STRAWBERRY-GROWING

BY

S. W. FLETCHER

The Rural Science Series

L. H. Bailey *Editor*

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BY

S. W. FLETCHER

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PREFACE

THE strawberry is distinctively North American. Most modern varieties sprang from species found only in the Americas. Progress in the domestication of this fruit was coincident with the introduction into Europe of American types. The acreage under commercial culture in the United States and Canada has grown from 1400 acres in 1854 to 150,000 acres in 1910. This is more than the combined acreage of all other countries.

This book aims to reflect modern commercial practice in North America. A history of the rise of strawberry-growing, together with a discussion of the origin, botany and breeding of the North American type, are presented in a companion volume, "The Strawberry in North America." All of the more than 1800 varieties that have originated in North America are described in Technical Bulletin 11, Virginia Agricultural Experiment Station, Blacksburg, Virginia: "North American Varieties of the Strawberry."

I have freely incorporated the experience of others, as is noted in the text. I am under especial obligation to Matthew Crawford, Cuyahoga Falls, Ohio, and to the Editor of the Rural Science Series. A number of the illustrations are borrowed, for which acknowledgment is made in the List of Illustrations.

S. W. FLETCHER.

STATE COLLEGE, PA.,
January 29, 1917.

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STRAWBERRY-GROWING

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CHAPTER I

LOCATIONS, SITES AND SOILS

COMMERCIAL strawberry-growing in North America may be said to have begun with the introduction of the Wilson, in 1854. At that time there were less than 1500 acres under commercial culture, and the annual production was about 40,000 bushels. Now there are over 150,000 acres, and the output is more than 8,000,000 bushels annually. Within these sixty years the market wagon and the sailing sloop have been displaced by the refrigerator express. House to house peddling has been succeeded by the coöperative selling organization. The strawberry season has been extended from five weeks to twelve months. The number of varieties has increased from 80 to 1800. It is a remarkable history. The rise of no other fruit has been as rapid, and none gives more promise for the future.

LOCATIONS

The man who has determined to enter the business of growing strawberries for market has several matters to consider before he will be in a position to select a suitable location for the enterprise. Among these are strawberry districts, the type of market, transportation facilities, the type of farming and labor.

Strawberry districts.

So far as natural advantages are concerned, no section has a monopoly of the oft-repeated claim of being "The home of the strawberry." Except in the arid sections where water for irrigation is not available, and in parts of the North Central states and adjacent provinces,

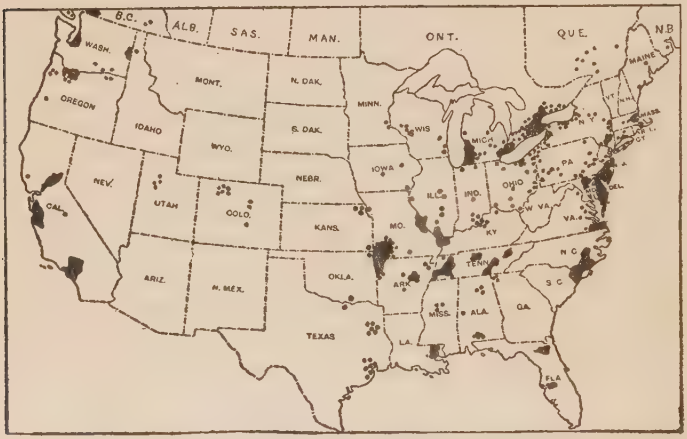


FIG. 1. — Location of the most important strawberry producing districts, as reported by the Census of 1910. Each dot represents 100 acres. A few small shipping districts in Nova Scotia and British Columbia are not shown.

which are extremely cold, the strawberry can be grown successfully nearly everywhere, if the market demand justified it. Commercial strawberry-growing is not restricted to sharply defined belts or zones, as is the case with the apple, pear, peach and other fruits. Although the great body of commercial planting is now concentrated in a comparatively few districts, these are quite impartially distributed among the various states and

provinces and embrace a great variety of conditions of altitude, climate and soil (Fig. 1). This leads to the presumption that practically every state and province has, at various points within its boundary, large areas of land that are as suitable for commercial strawberry-growing as any in the districts that now ship hundreds of car loads. The most important shipping centers are listed in the appendix.

Type of market.

It is necessary for the prospective grower to decide at the outset whether he will produce berries for the general market, or for the personal market. If the former, the location may be many miles from the market that he expects to supply. Distance from large cities usually means lower land values, more stable labor and a lower cost of production. On the other hand, it means higher transportation charges, greater opportunity for vexatious delays and loss in getting the fruit to market, and a less intimate touch with market conditions. The fruit is grown in considerable quantity, perhaps twenty-five acres or more, without special or intensive culture. It is marketed in car-lots, often through coöperative shipping associations. The grower deals with the wholesale merchant, not with the retailer or consumer.

When growing strawberries for the local or personal market, the location will be quite near the town or city to be supplied, usually less than forty miles; the closer the better, up to the limit of reasonable land values. A comparatively small acreage is grown, perhaps not more than two to five acres. Intensive culture is practiced and the fruit is marketed in comparatively small quantities, always less than car-lots. The grower deals with

the retail merchant or the consumer. These two types of strawberry-growing are distinct in their aims and necessarily are quite different in their methods.

Since about 1870 most of the commercial strawberry-growing of North America has been wholesale. In 1914 the car-lot movement in the United States, as reported by the Office of Markets and Rural Organization, was 14,553 cars. Probably this was over two-thirds of the total quantity marketed that year. In early years, the nearer the field was to the market the better the chance for profit. Rapid transportation, refrigeration, the telegraph and telephone have changed this situation. To-day, strawberry-growing is as likely to be profitable a thousand miles from a market as within five miles of it.

In choosing a location for wholesale strawberry-growing, it is desirable to seek a community where the industry is already established, so as to secure the advantage of numbers. It requires a considerable number of growers to secure recognition from the transportation companies in the way of satisfactory schedules and adequate shipping facilities. One shipper can make little headway in this respect. He cannot compete, when the market is distant, if obliged to ship in less than car-lots. In some districts, the berries are sold f.o.b. to buyers at the shipping point. This is a satisfactory method, but buyers will not come to districts where there are only a few growers. Furthermore, there is a stimulus to the average man in being located near other men who are growing the same fruit. From every point of view, a considerable number of growers and a large quantity of fruit concentrated at one shipping point are an advantage in wholesale strawberry-growing.

Transportation facilities.

Whether a wholesale or personal market is sought it is advantageous to be located where there are competitive means of transportation, such as two railroads, or a steamboat line and a railroad. Competition is not only the life of trade but also the chief incentive of freight rate reductions. A well equipped steamboat is superior to a refrigerator car. There is less jar, fewer odors and cinders, and the fruit arrives fresher, even though the trip by boat is longer than the trip by railroad. The advantage of a location which has a good road to the shipping point is obvious. The strawberry is very sensitive to jolts; spring wagons and hard surface roads are needed to put it at the shipping point in good condition. The closer the field is to the shipping point, the better.

Type of farming and labor.

Since this crop occupies the land but a comparatively short period, it readily lends itself to association with other lines of husbandry. In most of the large shipping centers the strawberry is grown as a main crop, but other crops are grown to some extent, supplementary or subsidiary to it. In the trucking sections of the Atlantic coast, as at Norfolk, and in market-gardens near large cities, the strawberry is but one spoke of a wheel of succession cropping, and occupies the land but one year or less. In other places, as on Vashon Island, Washington, and in California, the plants occupy the land from three to five years, sometimes longer. In a few places, as at Bowling Green, Kentucky, it is grown as part of a general farm rotation. In the Hood River and Yakima Valleys, Washington, the strawberry is grown merely as a filler between rows of young fruit-

trees. If other crops are to be grown with strawberries, these influence the choice of a location.

The strawberry requires more labor than most crops, especially at the harvest. There have been many disastrous failures because of a shortage of pickers. Many of the large plantations secure pickers from a distance and encamp them on the farm, but a local supply is a distinct advantage. This point should be considered in selecting a location.

SITES

Having fixed on a geographical location for the enterprise, the selection of a site, — which is the location with reference to local topography, — next demands attention. The nature of the soil usually is of more importance than the lay of the land, and may be the determining factor; yet there are several points about the site that should be weighed independent of the nature of its soil. These have to do mainly with air drainage, water drainage, earliness, wind protection and irrigation.

Air drainage.

Except when grown in connection with trucking or market-gardening, gently sloping land is preferred for strawberries, provided the soil conditions are favorable. The strawberry plant hugs the ground; it would suffer severely from frosts were it not for the fortunate circumstance that the blossoms open in succession over a considerable period. The plant, also, shows remarkable recuperative power, especially in the South, by sending out a new crop of blossoms immediately after the first crop has been destroyed by frost. Nevertheless, the loss

from frost often is serious. A sloping site, which provides cold air drainage to lower land, may give sufficient immunity from light frosts to justify the somewhat greater inconvenience of cultivation, as compared with level land. The slope need not be steep; a fall of two or three feet in one hundred may be sufficient to secure good air drainage. The steeper the land, the greater the inconvenience of cultivation and danger of soil erosion. An elevation considerably above the surrounding country is preferable, provided the slope is not steep or the soil poor. In the Chattanooga district, the growers find it more profitable to go high enough on the ridge to escape frost than to plant on the more fertile lower slopes. In Colorado, the high mesa or bench lands are preferred. Smudging may afford considerable protection if the site is frosty, but it is more economical to plant on an elevated site.

Water drainage.

A sloping site usually provides good water drainage, but not always. Poor drainage is one of the greatest difficulties of strawberry-growing in the Gulf states. Ridging and bedding may be resorted to, but sloping land is preferable, if available. In the North, especially in Canada and northern New England, it is desirable to select a site with enough slope to carry off melting snow, so that ice will not cover the field; frozen slush will injure strawberry plants if it covers them many days.

Exposure.

If a slope is to be planted, its exposure, or aspect with reference to the points of the compass, may have some bearing upon the success of the enterprise. A southern

exposure — one that faces the south — is earlier and drier than a northern exposure. It is, also, more subject to alternate freezing and thawing during the winter and early spring, which causes "honey-combed" soil, heaving, and breaks the roots. When earliness is essential, as it is in most southern districts that grow strawberries for northern markets, these disadvantages of the southern and southeastern exposures often are more than offset by the few days that are gained in the season of ripening. A gain in earliness of five days may be worth more than the larger yield that might have been secured on a northern or northwestern slope, or on bottom land. If the rows are run east and west and ridged slightly towards the south, earliness will be still more marked. Sometimes as much as a week is gained in this way. A southern or southeastern exposure dries off quickly in the morning and after a rain, so that picking can begin.

Unless early ripening is the chief consideration, a northern or northwestern exposure is preferable, since it is cooler and more moist. Late varieties should be planted on northern slopes or bottom land; usually they blossom late and so are likely to escape frost; and they ripen when upland soils often are beginning to get dry. In Canada and northern United States it is desirable to plant where the snow clings throughout the winter, and late into the spring.

Advantages of flat land.

However marked the advantages of sloping sites for inland locations, there are more commercial strawberry fields on level land than on slopes. The largest area of commercial planting on the continent is on the coastal plain of the Atlantic seaboard, extending from southern

New Jersey to South Carolina. The strawberry fields in this region are on flat land, and from twenty to seventy-five feet above sea level. Immunity from frost is not derived from air drainage but from proximity to the ocean. Earliness is secured by warm soils and a tempered climate. The advantages provided by slopes in inland locations here are assured without the attending disadvantages. Level land can be worked to better advantage than sloping land; it is more economical to till, there is less leaching and practically no surface erosion. Unless it is frosty, level land with a warm soil is preferable to a hillside, even though the slope has richer soil; fertility can be supplied more easily than the other essentials of a good strawberry soil.

When the topography does not provide marked air drainage and when frosts — not freezes — do little damage, bottom land may be suitable; usually it is richer and more moist than upland soil. In Florida, flatwoods land is preferred for strawberries after it has been drained. On the Delaware-Maryland peninsula, drained swamps are used for late varieties, as the Gandy.

Protection from wind.

In some sections, notably in the North Central states and adjacent provinces, it is desirable to protect the plantation from cold or drying winds. This region is subject to sudden and great fluctuations of temperature, severe winds and intense cold. One of the greatest difficulties is the drying west or southwest wind during the blossoming season. The wind and dust dry out the blossoms so that they do not set fruit well. In winter, drying winds are more likely to injure the plants than intense cold.

When the country is rolling, partial protection is secured by planting on the protected slopes; when level, shelter belts of trees or bushes are necessary. Mulching is fairly effective, temporarily, but does not give permanent and continuous results like a shelter belt or windbreak. On the northern prairies, the windbreak is preferably of native trees, as the green ash, hack-berry, white elm and box elder; but a number of introduced species are used to advantage, especially the white willow, golden willow and several evergreens. The windbreak should extend along the south and west sides of the plantation. Some plant one or more rows on the north side, also, so that the snow will more readily stay within the area and mulch the plants. Rows of raspberries, currants and other bush-fruits may be planted eight to thirty feet apart, with rows of strawberries between. The bush-fruits cause snow to drift in and stay late, and also protect the strawberries from drying winds in summer. Lath screens have been used, but are not practicable outside of home gardens.

SOILS

"The ideal strawberry soil" has been described at various times by various persons. Compiling these descriptions, it is found to vary from almost pure sand to heavy clay or muck. This leads to the conclusion that there is no ideal soil for the strawberry, but that some soils are more desirable than others in certain localities and for certain purposes. Strawberries are grown commercially on almost every type of soil, provided it is well drained and at least fairly fertile, whether the fertility is natural or supplied.

Soil preferences in different regions.

The typical strawberry soil of the Atlantic coastal plain, from New Jersey to South Carolina, is a light sandy loam. The soil is not rich, but it is warm and quickly responds to under-drainage and enrichment with green-manures and fertilizers. The water-table is quite close to the surface; at Selbyville, Delaware, during May or June, standing water will be found at a depth of three or four feet. This is favorable to the crop in soils of such open texture. The opposite extreme — a heavy clay or muck — is preferred in this region for late berries. Some of the most profitable fields on the Delaware-Maryland peninsula are gum swamps near the headwaters of streams, that have been cleared and under-drained. These rich, moist lands are commonly called "Gandy land" because of their special value for this variety. There is a large area of clay loam in southern New Jersey, notably in Cumberland county, that has made this section famous for late berries.

In the early years of Florida strawberry-growing, pine land was considered too sandy for strawberries, but in recent years it has been used quite successfully. A good quality of flatwoods is more retentive of moisture than other Florida soils. It is a dark, sandy loam, one and one half to two feet deep, with a clay subsoil. Hammock land has a more mucky soil, which does not resist drought as well. A warm, dark-colored, sandy loam is preferred to heavier and richer soil, even though it is poor in fertility; plant-food can be supplied easily, but warmth and earliness cannot, except to a slight extent by drainage. Many Florida strawberries are grown on an almost sterile sand which is used simply as a medium in which

to anchor the roots of the plant while the grower nourishes it with commercial fertilizers.

In the Gulf states, dark pine land is considered well adapted for strawberries, if sufficiently rolling to carry off surface water but not steep enough to wash. The retentive, marly clay table lands of central Mississippi have been found well adapted for this crop. In the Chattanooga district, shaly or gravelly ridges are preferred. Throughout the Southern states very rich soil is avoided; it produces sappy, over-grown plants, and the berries do not carry well. In the Pacific states, the heavier loams and light clays are preferred to sandy soils, because they are more fertile, more retentive of moisture and produce larger crops. This is especially true where irrigation is practiced; sandy soils require much water.

A survey of soil preferences in different parts of the continent discloses the fact that more strawberries are grown on a sandy loam underlaid with clay than on any other soil type. The demand for early berries has had much to do with this choice. The most popular strawberry soil in the northern and central states is a gravelly loam with clay subsoil. Heavy loams, silts and light clays are preferred for late varieties in the East and are used very generally on the Pacific coast for all varieties.

QUALITIES OF GOOD STRAWBERRY LAND

The prevailing practice has been indicated in the preceding paragraphs. Some of the qualities that make a soil suitable for strawberries now will be considered.

Texture and water-holding power.

One of the most successful growers of his time, J. M. Smith of Green Bay, Wisconsin, produced crops of 12,000 to 15,000 quarts an acre upon an almost pure sand. However, he applied forty two-horse loads of manure each year. The lighter the soil, the more deficient it is in fertility and water-holding power and the greater the need of farm manures or green-manures. Light soils give earlier and better flavored berries than heavy soils but the yield is not as large and the expense for fertilizers is heavier. Before early berries from the South reached northern markets, nearly everybody in the North planted on light soils, so as to secure early berries. Since about 1870, the drift in the North has been toward heavier soils, as there is no longer any advantage in growing early berries except for near markets. Most northern growers now find their surest profit in growing the heavy yielding mid-season or late varieties; hence they select the stronger loams, which produce a large crop without heavy fertilizing. In 1893 and 1894 the New Jersey Experiment Station canvassed that state in order to determine the comparative yield of strawberries upon sandy and clay soils. In 1893 the average yield to the acre on clay loams, 290 growers reporting, was 2909 quarts; on sandy soils, 240 growers reporting, 2508 quarts. In 1894, 306 growers reporting, the clays yielded 3223 quarts, while the sandy soils averaged 2359 quarts, 387 growers reporting; a gain of 864 quarts for the heavier soils.

Sandy or gravelly loams are preferred because they do not bake, are easily worked and water moves through them quickly. The strawberry crop requires not only a large quantity of water but also that it be supplied quickly. The fruit must be developed from blossom

to maturity within a period of about four weeks. This means that the texture of the soil should be such that water will pass through it quickly. The two extremes — a dry, leachy sand or gravel and a stiff, baking clay, are equally objectionable.

A sandy soil is valuable only when it has a clay subsoil within two or three feet of the surface; then it will hold the fertility that is added to it. The more sand or gravel there is in the surface soil the more urgent the necessity for a tight subsoil; the more clay or silt in the surface soil, the greater the need of an open subsoil. The character of the subsoil is fully as important as that of the surface soil. The worst soil for strawberries is waxy or gumbo land which packs and cracks whenever it gets dry. The roots of the strawberry are easily torn by this cracking, since the plant is shallow rooted.

The presence of gravel or chert in the soil is an advantage. Gravel acts as a surface mulch, conserving moisture and preventing crusting. Strawberries often grow excellently on land that is so stony that scarcely any soil can be seen; it is cool and moist beneath the gravel. Much of the strawberry land in Oswego County, New York, is a stony loam; in some fields the stones are so numerous that there appears hardly room for the plants to grow between them. Many of the best fields in the Ozark region of Missouri and Arkansas are very cherty. On the other hand, large stones interfere with cultivation and the training of runners, and hinder the pickers.

Muck swamps sometimes may be used to advantage. The land should be drained so that the water-table stands not less than two feet from the surface. It is best to cultivate it in corn, cabbages, celery, potatoes

or other tilled crops for two or three years before setting strawberries. On muck soils, strawberries make a rank growth and may be unproductive unless the food supply is balanced with applications of the mineral fertilizers. If near small water courses, muck land may be frosty; if near large bodies of water, it may be quite free from frost. Muck should be used only for late varieties. Peat soils are unsuitable; they dry out quickly, are difficult to work and are deficient in mineral plant-food.

Fertility.

Until about 1850, it was contended that the strawberry requires poor soil, otherwise it runs to vines and produces little fruit. This assumption was based on the fact that varieties of the Scarlet, then most commonly grown, did run to vines when planted on heavily manured and deeply trenched land, as was the custom at that time. The modern strawberry responds to heavy fertilizing and is unprofitable upon poor soils. The most notable exception to this general rule is found in the South, where rich soils, especially those abundantly supplied with nitrogen, should be avoided, since they produce a rank growth of vines and the berries ripen unevenly and do not carry well. The stock advice, "Land that will make thirty to forty bushels of corn to the acre is good strawberry land," is sound. In Missouri, it is considered that land that will produce 200 bushels of potatoes an acre should average 200 crates of strawberries without fertilizing. The strawberry plant feeds near the surface; it does not forage deeply into the subsoil. Moreover, it matures its crop in a short period, especially in the North; hence the need for an abundant supply of plant-food in the surface soil.

It makes little difference whether the plant-food is in the soil at the outset or is put there as fertilizer. If it was supplied by nature, the cost of production will be reduced that much. Even though the soil is poor, if it has the other necessary qualities, especially good drainage, fertility may be added from fertilizer sacks. A large part of the strawberry industry is based on this proposition.

Since colonial days, land that has been cleared recently has been preferred for strawberries. A large proportion of the strawberry fields of the South are planted on "new ground." The superior crop-producing power of new ground, as compared with old land, is due partly to its larger supply of available plant-food, but mostly to its excellent physical condition. It is full of leaf mold and humus, which hold moisture well. In some localities, virgin land is planted to strawberries immediately after being cleared; in others, it is cropped in corn one or two years to subdue the sprouts and rank growth of forest herbage. In Florida and parts of the Gulf states, strawberries on new ground tend to run to vines, and it is best to crop the land two or three years before using it for strawberries.

Drainage.

Good drainage is the most important quality of strawberry land. Fertility can be added, texture and water-holding power improved, but unless the soil is well drained naturally or is susceptible of under-drainage it will not produce profitable crops. The character of the subsoil, whether porous or impervious, and its depth from the surface, is one of the first points to observe. A sloping site usually secures good drainage, but some heavy up-

land soils are so retentive or have such impervious subsoils that they require under-drainage. The water-table should not be closer to the surface than two feet. Poorly drained "crawfish" land may do fairly well the first year or two without under-drainage but good crops are not certain. A few varieties thrive in heavy, moist land but none thrives in wet land. Open ditches may be used to advantage in draining swamps. Blind ditches are useful for draining wet places in a field otherwise well drained. The most practical method, in most cases, is to under-drain with tile. Much of the strawberry land in Florida, Alabama, Louisiana and Mississippi is flat; water stands on it after heavy rains, often to a depth of one inch or more. Under-drainage will help these soils, but it is necessary, in addition, to throw the land into beds or ridges as described in Chapter II.

CHAPTER II

PLANTING

It is not well to set strawberries in freshly turned sod land, or land that has been lying out for several years and has grown up more or less with grass. Recently plowed land usually has air spaces between the pieces of turf; these make it difficult to secure a good stand of plants. It is also infested with white grub. If sod land is used it should be plowed several months before planting. Land infested with nut-grass, bermuda-grass, Johnson or witch-grass, should be avoided; if obliged to fight these weeds the cost of cultivation will be doubled.

PREPARATION OF THE LAND

In localities where strawberries normally are planted in the spring, fall plowing is desirable except on very light soils. It is especially advantageous when turning under a sod. Fall plowing makes the land warm, so that it can be fitted and planted early in the spring. It kills white grubs, and stores rainfall. If the soil is rather heavy it may be cross-plowed in the spring, but the disk or cutaway harrow usually will put it in condition. Spring plowing for strawberries should be shallow; the soil dries out as deeply as it is stirred. When planting is to be done in the summer or fall in the North, do not plow at all unless this is necessary to cover weeds; a firm plant-

bed is very essential at that time of the year. Sandy soils, unless covered with herbage, should be plowed in early spring. The essential point is to plow early enough so that the soil will be firm and the herbage decayed before the plants are set; in some localities this means fall plowing; in others, winter or spring plowing.

The depth to plow depends mainly on the nature of the soil, incidentally on the method of culture. Before 1860, strawberries were commonly grown in land that had been trenched about two feet deep. Trenching has not been necessary, even in the home garden, since the introduction of the Wilson. Subsoiling is a more modern substitute for trenching. Light soils, particularly if the subsoil is open, are not benefited by subsoiling and may be injured. When strawberries are planted on clay land that has a tight subsoil close to the surface, there may be some benefit from subsoiling. In most cases, deep plowing in the fall or early winter is preferable to subsoiling. On many soils under-drainage secures permanently the beneficial results that subsoiling secures temporarily.

Fitting the land.

There is special need of compactness; if strawberries are set upon a loose or lumpy soil the stand will be poor. If possible, fit the land a week or ten days before planting. The final harrowing should be shallow in order that the soil may not dry out deeply. If the soil is heavy, the surface lumps should be reduced with a pulverizer, planker or drag, but not with the roller. Sandy soils should be rolled until quite compact. If the soil is not firm at planting time, subsequent rains will compact it, leaving the crowns of the plants high above the surface. A plank drag is preferable to a harrow for the last working

since it fills the horse tracks better and leaves the land smoother for marking out.

Bedding and ridging.

Level culture is preferable except when earliness is desired or surface drainage is poor; the roots keep cooler and the supply of soil moisture is more equable. Ridging to secure earliness has long been practiced, especially in the South. The ridge is made by throwing two or more furrows together (Plate I). These are knocked down to the desired height and shape with a drag; each one accommodates one row of plants. Usually the ridge is three to six inches high on the back or north side, and grades down to a level on the front or south side, thus presenting the maximum surface to the sun. A gain in earliness of four to eight days may be expected, as compared with level culture. Ridging or bedding to secure surface drainage as well as earliness is used most commonly in the South, and occasionally in the North. In Florida and the Gulf states, ridging is necessary except on the lighter sands; heavy midsummer rains often cover the flat lands of this region with water to a depth of one or two inches. The width of the bed or ridge is determined mainly by the water absorbing power of the soil. One-row ridges and two-row beds are used mostly, but three- to ten-row beds or "lands" are used sometimes on the lighter soils. The lower and wider the beds the better, provided they will carry off the excess water. High, narrow beds dry out quickly. Wide beds hold mulching material better. The height of the bed or ridge varies from two to eight inches. In Florida, the ridges are commonly three to four feet wide and four to five inches high.

PLATE I. — *Above*, a hillside strawberry field in Virginia; *below*, knocking down the ridge with a drag, Norfolk, Virginia.

SEASON OF PLANTING

Strawberries are planted commercially every month of the year at some point on the continent. The heaviest planting is in the spring; but February is springtime in Arkansas, and May in Ontario. The limits for commercial planting in each locality are rather narrow.

Factors that determine the time of planting.

The factors determining the time of planting are temperature, moisture and the nature of the soil. Plants cannot be set in frozen ground nor will they thrive if the ground freezes deeply soon after they are set. Wherever the ground freezes to a depth of six inches or more, late fall and winter planting is impracticable. If fall-set plants are mulched, they may escape injury, but nothing is gained unless they make enough growth during the fall and winter to produce at least a light crop the following spring. This restricts practically all of Canada and the northern half of the United States east of the Rocky Mountains to spring planting, save for the very small planting in late summer in market gardens. South of the latitude of Washington, D.C., strawberries can be planted any time of the year when it is not very hot or very dry.

Newly-set plants must have plenty of water. In irrigated regions, plants can be set any month that the ground is open, since the water supply is under control. In humid regions, the best time to plant depends largely on the occurrence of rains.

Strawberries can be set in the fall in sandy soils with safety when they would fail on clay soils, because sands do not heave. The plants suffer less from cut-worms in fall or winter planting, the stand is surer and it is easier

to get good nursery stock. In the rush of spring work, planting is likely to be delayed; many fields that should be set in April are not set until May.

Planting seasons in different regions.

Fully ninety per cent of the strawberry planting in Canada and the United States north of the latitude of Washington, D.C., is in early spring, as soon as the ground can be worked. In the North, each locality has a planting season of four or five weeks which experience has shown to be dependable; earlier or later planting is attended with risk. Proceeding southward, the possible planting season is lengthened, as well as advanced on the calendar. Practically all of the planting north of Oklahoma, Arkansas, Tennessee and Maryland is in the spring.

The shorter the season of growth, the more uncertain are the results of fall planting. The land must be heavily manured and fertilized so that the plants may make a maximum growth before they are checked by cold. Rich, mellow, market-garden loams are most suitable for fall planting. Potted plants or strong layers are commonly set in late August or September. The chief advantage of fall planting in the North is that land can be used from which a crop of early vegetables has been removed, and it is released in time to plant another vegetable crop the following year; hence this method appeals most strongly to market-gardeners. Incidental advantages are that there is no trouble with white grub, no blossoms to cut off and at least two-thirds of the trouble in fighting weeds is avoided. On the other hand, the plants are not easily obtained and are expensive; the weather is more likely to be unfavorable so that special care is required in planting; there is more danger of winter injury; the

crop is not as large. Fall planting is too expensive and uncertain to be generally useful in the North. It is a special practice, used successfully only in a few market-gardens and home gardens.

From the Delaware-Maryland peninsula southward along the coast to South Carolina, if the ground is prepared in the fall, plants can be set any time during the winter when it is not freezing. The plants become established in the soil so that they start off quickly in the spring. It is a distinct advantage to have such a long period during which planting can be done successfully.

In the coast region of North Carolina, most of the planting is done in October and November. Florida growers can plant any month of the year, but most of the commercial fields are set from August to October. September and October are the safest months, but if the weather is favorable, August planting gives a better crop. In south Florida, plants are set from June to November. Strong plants set in November will begin to bear in January and keep on fruiting more or less until May; sometimes November plantings yield as heavily as those set earlier.

Most of the commercial fields in the Gulf states are planted from September to March. August and September plantings are liable to suffer from drought except along the coast. In the southern part of Alabama, Georgia, Mississippi and Louisiana, plants set in November and December make considerable growth during the winter and bear one-half to two-thirds of a crop in the spring, but not as heavily as August and September plantings. In the central and northern parts of these states, plants make but little winter growth and must be set in August or September in order to get a crop the next spring.

Much of the planting in this region is during February and March and these plants do not bear a full crop until a year later. Along the Gulf coast of Texas strawberries are set from October to December. These yield a good crop the next spring and are then plowed under.

Arkansas is on the dividing line between spring planting and fall planting. At Judsonia, fall planting is satisfactory on the lighter soils but the crop harvested the following spring is insignificant; the chief advantage is in the earlier start. Most of the planting in this district is in early spring; that is, in February. In the Ozark region the most favored season is from the middle to the last of March; this is two weeks earlier than in northern Missouri. Practically all of the planting in Tennessee, Kentucky, Ohio and other parts of the Mississippi Valley is in early spring, from February in southeastern Tennessee to early May in northern Wisconsin.

The planting season in California is remarkably flexible, since irrigation gives the grower independence of rain-fall and the climate is very equable throughout the year. Near Los Angeles, plants commonly are set from August to November, so as to be well rooted before the season of cool nights. These bear a full crop the following April and fruit more or less continuously until October. In the Watsonville and Florin districts, near San Francisco, most of the planting is in October. These plants begin to bear the following March and fruit continuously until October or December, according to the season. A crop of strawberries may be produced in California at any time of the year by manipulating three factors — the time of planting, irrigation and runner cutting. Fall planting, from August to October, is preferred in the coast region of Oregon, Washington and British Columbia,

which has an equable and humid climate. This is the only section north of the latitude of Washington, D.C., in which fall planting is uniformly successful. Spring planting is preferred in the interior districts of this region and in the mountain states of Colorada, Idaho, Utah, Montana, Nevada and Arizona.

To summarize the prevailing practice, spring planting is preferred in all of Canada except the coast region of British Columbia, and in eastern and central United States as far south as Virginia, Tennessee, Arkansas and Oklahoma. In these states and those farther south, and on the Pacific coast, most of the planting is done in the fall or winter months.

THE PLANTS

The methods of propagating strawberries and the kind of plants to set are described on pages 226 to 232. If the plants are to be secured from a nurseryman, the order should be placed early; no stock suffers more from late delivery. Do not submit to substitution of varieties at the nursery. In the North, early orders are shipped during cool weather and are more likely to arrive in good condition than late orders.

Local-grown plants are somewhat preferable, because they can be dug a short time before planting, and because they are acclimated. This is of little practical importance except in extremes of climate. Manitoba growers, for example, find plants from Minnesota or Wisconsin preferable to plants from southern Ontario, which has a much milder climate. It may pay to secure plants of early varieties from the North and of late varieties from the South; the climatic change accentuates the season of ripening.

If less than 500 plants are ordered, they may come by parcel post; if more, by express. Strawberry plants weigh twenty-five to thirty pounds a thousand, packed. Freight should be used only when the distance is short, and during cool weather. An advantage of express is that the packages are carried in open cars, whereas mail is carried in air-tight pouches.

To ascertain how many plants are required for an acre, multiply the number of feet between plants in the row by the number of feet between rows; this gives the number of square feet occupied by one plant. Then divide the number of square feet in an acre, which is 43,560, by this sum. Some growers order one-tenth more plants than are needed to set the field; the remainder are heeled in so that the plants do not touch. Three weeks later all plants in the field that have not made a good start are pulled up and new plants set.

Preparing plants for setting.

Plants from a nursery should be unpacked immediately in a cool place. After dipping the roots in water place the moss in which they are packed upon the floor and set the bunches on it, close together. If the plants are needed for setting within four or five days, bank the moss tightly around the sides and keep them watered. If not, break open the bunches and heel in the plants. Good plants have fresh green leaves and yellow or orange-colored roots; plants with black or dark brown roots should not be used. Plants packed in wet sphagnum should carry a week or more. Plants that have been packed for some time and have become warm may be bleached. They should be heeled in, partially shaded, and watered until they have assumed a healthy color.

Never set wilted plants; put them in water or heel them in until they recover. If the plants were frozen between the nursery and the farm, open the bundle, wet them thoroughly and put them in a dark, cool cellar, packed in moss or sand. They will not be injured if thawed slowly.

Heeling-in.

Unless the plants are home-grown, it is nearly always desirable to heel them in for a few days at least before they are set permanently in the field. It is essential to have an open, well-drained soil, preferably on a slight slope so that there will be good surface drainage. A shallow trench is opened with a spade deep enough to hold the roots without cramping them, and with the land side slanting a little. The bundles are opened and the plants spread thinly along the trench, crowns even with the surface. The plants are not trimmed unless they are to stay there a month or more. The roots of this first row of plants are covered with soil removed in the next course of the spade, and so on with successive rows. The soil is tramped very firmly over the roots. A trench about fifteen feet long will accommodate 1000 plants. Stake each variety, water often and keep the bed shaded with sacks, lath screens or straw when the sun is hot. Should there be freezing weather, cover it lightly with straw. Plants may be kept heeled in several weeks, if necessary, while waiting to put the land in good condition for planting, or for a cool cloudy day. They throw out new roots and the leaves become darker green. However, the sooner strawberry plants are set in their permanent quarters the better. Ordinarily plants are heeled in for only two or three weeks. Occasionally they are kept in the bed much longer, as in a method called "the

new strawberry culture" which has been advocated by a few northern growers. Dormant plants are trimmed and are heeled in from one-half inch to one inch apart, according to how long they are to stay there. By June these

FIG. 2. — A strong runner plant. The lines indicate how it should be trimmed for setting.

plants are very large, and are then transplanted to the field. By fall the plants will have thrown out many strong runners, while the expense of tillage and training has been much reduced. This method is useful only when the ground is not ready for spring planting or when the plants are weakened by long travel.

Trimming.

The roots are shortened one-third to three-fourths (Fig. 2). Some growers prefer roots four or five inches long; others shorten them to one or two inches. If planting in a mild climate and on a sandy soil, the roots may be shortened much more than would be advantageous in a rigorous climate and on heavy soil. Ordinarily, the roots are shortened to about three inches. If much longer than this, it is hard to set the plants, as the roots wad in the hole. Some growers think that if the old roots are cut back heavily the new roots are more likely to grow downward, so that the plant will be more deeply rooted. This contention does not appear to be well founded. The roots are clipped off with pruning shears or knife while tied in bundles. Ordinarily, all dead or diseased leaves and runner strings are trimmed off before the plants are set, and but two or three leaves left. Retain old leaves instead of young, as they are less likely to burn. In Florida and the Gulf states, some growers retain practically all the leaves, because they protect the crown from the sun.

THE SPACING OF THE PLANTS

To secure the fullest use of the land and economy in tillage, the plants should be spaced uniformly. There are two distinct problems in spacing plants — the best distance between plants in the row, and the best distance between rows.

Distance between plants in the row.

This depends on the plant-making habit of the variety, method of training, location and nature of the soil. If the runners are not to be restricted, the habit of the

variety should be known before marking out the field. Some sorts, as the Warfield, Dunlap and Crescent, normally make a large number of runners; these varieties may be set thirty to thirty-six inches apart in the row, on average soils. Varieties of fair plant-making ability, as the Wilson and Bubach, may be set twenty to thirty inches apart in the row. Some sorts throw out only a few short-jointed runners; these must be set fifteen to twenty inches apart. Glen Mary is an example. Varieties which are practically runnerless, as the Pan-American, should be set even closer. When the runners either are to be kept off entirely or restricted, the distance between plants in the row is correspondingly shorter. In southern California, Brandywine plants are set six to ten inches apart. On the north Pacific coast, Magoon are set in hills three to four feet apart. These are the two extremes; the average interval in hill training is about one foot. In hedge-row or spaced row training, the most suitable interval between mother plants can be determined quite definitely, as there should be from six to fifteen inches between plants after the runners are set. A heavy, rich soil makes strawberries "run to vine." In the territory bordering Puget Sound, a single plant may have a spread of over three feet; on the Atlantic coast the largest plant may not cover half that space.

Distance between rows.

The distance between plants in the rows is determined mainly by environmental factors. The distance between rows is determined, to a large extent, by cultural convenience, although location, soil and variety have some influence. The method of tillage, whether with hand or

horse, is the chief factor. If plants of strong-growing varieties are set at least thirty inches apart in the row, they may be worked both ways several times with a horse cultivator before they have thrown out many runners; this saves much hand hoeing. Most growers, however, use the horse cultivator but one way, and set the plants closer together in the row. The interval should be such that it can be covered with one round of the cultivator conveniently. Where eight or nine inches of mulching material are needed, the rows should be six feet apart in order to accommodate the large amount of straw that is pushed into the middles when the plants are uncovered in the spring.

Whether the plants are set alone or with a companion crop may affect the distance between rows. In the Norfolk district, strawberries are set between rows of potatoes, cabbages and other truck crops. This leaves the rows five to six feet apart after the vegetables are removed, which is one reason why wide matted row training is preferred in that district.

SPECIFIC EXAMPLES OF SPACING

The great body of commercial planting in Canada and northern United States is in the matted row; the plants are set fifteen to thirty inches apart in the row and the rows thirty to forty inches apart. Under hill training in market-gardens, strawberries are grown in slightly raised beds five feet wide. The plants are set one foot apart each way, making four rows to the bed. A space of two feet is left between the beds for a path. This method was practiced near Boston over a century ago. When planting in the fall, especially if potted plants are used,

northern growers frequently set double rows; the plants are ten to fifteen inches apart in the row and the twin rows twelve to fifteen inches apart. An interval of twenty-four inches is left between each pair of rows. The plants are kept in hills.

In Florida and those sections of the Gulf states where strawberries are grown in hills, there has been a decided drift recently towards horse tillage, with a consequent widening of the space between rows. Those who practice hand tillage set the rows eighteen to twenty-four inches apart, with plants eight to fifteen inches apart in the row. Some prefer double rows; the plants are ten to fourteen inches apart in the row, and the interval between the sets of rows is about eighteen inches. The double row is more economical of mulching material and there is less likelihood that drifting rains will throw sand upon the plants. Those who use horse tillage, space the rows three to three and one-half feet apart, with plants ten to fourteen inches distant in the row, whether there is a single row on each drainage ridge, or several rows. Near Starke, strawberries are set on narrow beds holding two rows eighteen inches apart, with the plants four to six inches apart in rows. In Texas under hill culture, plants are set eighteen to twenty-four inches apart, either on single row ridges, which are eighteen inches apart, or on double row ridges, which are three feet apart. Where the narrow matted row is used, the distance between rows is commonly three to three and a half feet, with plants twelve to twenty-four inches apart in the row.

The interval between plants is shorter in southern California than in any other part of the continent. Near Los Angeles, plants sometimes are set in double rows, six

PLATE II. MARKING OUT THE LAND. — *Top*, a home-made revolving spacer, used at Norfolk, Virginia; *bottom*, six-row iron wheel marker.

inches apart each way, with an interval of eighteen inches between each pair of rows. It takes 100,000 plants to set an acre, as compared with 5000 required under matted row training in the northeastern states, and 3500 on the North Pacific coast. Most southern California strawberries, however, are set in single rows eighteen to twenty inches apart, the plants six to ten inches apart in the row.

Under hill training in the Hood River Valley, Oregon, the rows are spaced two and one-half to three feet apart and the plants twelve to fifteen inches apart in the row. In the Puget Sound region, Magoon is set three and one-half feet to four feet apart each way and kept in hills. The double row is used considerably in the irrigated districts of the northwestern states. The plants are set eighteen inches apart each way and kept in hills, with thirty inches between each pair of rows.

MARKING OUT THE LAND

It is important to have the rows straight, wholly aside from their appearance. The land is then uniformly occupied, and tillage implements can be run very close to the plants, thus saving much hand hoeing.

The simplest method of marking out is with a garden line. This is most useful in the home garden, and when plants are trained in hills. Stretch it and set a row of plants a few inches to one side. In larger operations, a check line may be made of number sixteen wire, well annealed, with a mark or button every two feet, or whatever may be the distance desired between plants. When laying off large fields into rows at least thirty inches apart, some are satisfied with the results secured with a light plow, or single shovel. Stakes set at the end

of the row and in the middle are used to guide the plowman, as in laying off for corn. Unless the man and the mule are equally adept the rows are only approximately straight. This method is useful when the land is so stony that the dibble cannot be used to advantage, and on steep land, where it is necessary to follow the contour. The plants are set against the land-side.

A light peg marker is used most, especially for the matted row. In a piece of two by three inch scantling, twelve to eighteen feet long, preferably of white pine or other light wood, set wooden or gas-pipe pegs about eighteen inches long. The teeth should slope backward a little. There should be a number of holes in which to put the pegs, so that the spacing can be varied. Some use chains, instead of pegs, but these are easily deflected by clods and stones. If the marker is to be pulled by a horse, attach ordinary shafts; if by a man, use shorter and lighter shafts set closer together. An upright strip is nailed to each end of the head piece; a man follows the marker with his hand on this guide piece, to see that the inside peg runs exactly on the line made by the outside peg on the previous round. Lay off first a straight row on one side of the field with a line; if this base line is straight, subsequent rows should be straight. Some mark one way with a corn or potato-planter and check with a very light peg marker twenty-eight feet long and drawn by hand.

A sled marker is preferred for some soils, especially when the land is marked but one way. This may be made of two by six inch scantlings, rounded at the front end, nailed to two two by twelve inch planks, and provided with shafts. For small fields and mellow soils, the runners may be made of one inch boards two

feet long and six inches wide. This is pushed or pulled by hand.

A wheel marker that covers six rows at a round is shown in Plate II. Those that mark the land both ways at a round, thus locating the exact place for setting each plant, are preferable. One of the most serviceable of these is described by F. E. Beatty:[1] "Take a wooden wheel sixteen inches in diameter and tack two cleats on the rim directly opposite each other. Every time these cleats come in contact with the soil they make a dent. If you use a sixteen inch wheel, the dents will be twenty-four inches apart. Set this wheel in a frame with a hinge. This frame is bolted to a two inch board, which should be seven feet long, one wheel frame bolted to each end and one directly in the center, marking three rows at a time three and one-half feet apart. The hinge is to allow the wheel to adjust itself to any unevenness of the ground and thus make a continuous mark to follow in setting. The best way to draw this is by means of shafts and a man will draw it straighter than a horse." A home-made revolving spacer, checking two rows at a round, is shown in Plate II.

Rows should be laid off lengthways of the field to economize time in tillage. In large fields there should be a road through the center, both ways, with the packing shed in the middle. Cross alleys every ten rods are a convenience in mulching and harvesting. When earliness is important, the rows should run north and south unless the land is steep, in which case they should follow the contour. When wide beds are used for surface drainage, have an even number of rows in each bed; if there is an odd row, the pickers may skip it.

[1] "The Strawberry," Vol. I, No. 2 (Feb., 1906), p. 28.

ESSENTIALS TO SUCCESS IN PLANTING

Strawberry plants are easily injured by heat and dryness. In humid regions, wait for a cool and cloudy day, unless the planting season is already far spent. If there can be no delay, planting is best done in early morning and late afternoon. When irrigation is available, planting can be done at any time of the day, but it is prudent to avoid midday.

There are three essentials to success; the roots must be kept cool and moist, the soil pressed very firmly around the roots and the crown left at the right height.

Methods of protecting the roots.

The plants should be packed tightly in shallow boxes and covered with wet burlap before taken to the field. There they are placed, roots downward, in buckets containing a few inches of water. When planting a large field, a barrel of dampened plants, covered with wet burlap, may be placed at the end of each row.

A handy tray for setters is made by putting a bail on a tin pan about five inches deep. Some prefer a hooded basket (Plate III). It is not necessary to puddle the roots with clay before planting; if they are kept damp and cool, that is sufficient protection. Atmospheric conditions and the rapidity of planting will determine the margin of safety. The droppers should not get more than a few plants ahead of the setters, unless it is raining or cloudy.

Firm setting.

It is hardly possible to set plants too firmly in ordinary soils. Loose planting is responsible for many poor stands. The lighter the soil, the greater the necessity for firming

PLATE III. DETAILS IN PLANTING. — *Top left,* tin hooded setting basket; *top right,* Irish potatoes and strawberries as companion crops, Norfolk, Virginia; *center,* hand planting without the aid of a tool, at Norfolk; *bottom,* strawberries as a filler crop between apples, Hood River, Oregon.

it around the plant. Place one foot on each side of the crown after the plant is set, and very close to it. Then rise on the balls of the feet. A test of good setting is to give the plant a quick jerk by one leaf; if the leaf breaks without disturbing the roots, the plant is set firmly enough. Sandy soils should be rolled heavily before planting, and perhaps after planting, also. If the crowns are too high rolling may injure them.

Depth of planting.

When planted too deep, the crown is covered with soil and rots. When the loose soil made by harrowing and marking out has settled, the crown should be even with or a trifle above the surface. Years ago it was considered essential to spread the roots out very carefully upon a small mound of soil in the bottom of the hole. Mound planting is unnecessary; it is sufficient merely to keep the roots from wadding.

If the land is marked out both ways, do not set the plants exactly in the center of the cross mark; during a heavy rain, water will run down the furrow and wash soil over the crowns. Set the plant in one corner, just outside the cross mark, and use the same corner all the time so as to keep the rows straight.

METHODS OF SETTING

The plants are set by hand, or with the spade, dibber, hoe or transplanting machine. The dibber and spade are used most commonly.

Hand setting.

On loose, sandy loams, properly fitted, the hole is made easily with the hand, using one dropper to two set-

ters (Plate III). The roots should hang at a slight angle, so that the soil may be packed down upon them. The crown is placed level with the surface and the roots spread against the slanting side of the hole. Soil is pressed firmly against the roots, and loose soil left on top. Heavy rolling is necessary, after the field is set. Under favorable conditions one man can set 3000 plants a day without the aid of a dropper. Hand setting is practiced, also, when the rows have been laid off with a light turning plow and the soil is so gravelly that a spade or dibber could not be used to advantage. Plants are set on the land-side of the furrows, and enough soil pulled over the roots to keep them in place until men who follow with hoes can fill in the furrows and tramp. Occasionally the furrow is filled with a plow, but this is rarely satisfactory. Two men with mules can lay off rows for four setters. It takes one dropper to each setter, and one follower to fill the furrows and tramp; thus there are fourteen men in a planting gang. This method is used considerably in Maryland, Delaware and Arkansas.

Spade setting.

A spade is preferred for heavy soils. The method is described by Matthew Crawford. "A man and a boy work together, one carrying the pail and the other a bright sharp spade. The ground being marked out, the spade is set squarely across the mark at right angles to the row and thrust down at an angle of forty-five degrees. It is then pushed forward until there is sufficient room back of it for the boy to place the plant in position. He holds it there until the spade is withdrawn and the earth falls back on the roots. As the man with the spade steps forward to make another hole he sets his foot over the

roots of the last plant, pressing the earth firmly against them. A man and boy can set 5000 plants in a day."

The spade is pressed into the ground at a slight angle in order that there may be no cavity beneath the roots. Some growers fill the hole by thrusting the spade about four inches from the plant and pressing towards it. Others work backward, with the spade facing the setter. Sometimes a narrow wooden spade is preferred. It is made of hickory and has a wedge-shaped end four inches wide and six inches long, the cutting edge being protected with metal.

Dibber setting.

Florida growers use a large, round dibber called a punch. It is made of wood and has a steel point. A flat dibber is preferable, since it makes a broad opening somewhat like that of the spade. It can be made by the local blacksmith from a piece of heavy sheet iron or steel, sixteen inches long, four inches wide and weighing about two pounds. The upper end is rolled to fit the hand and the cutting end beveled to a sharp V.

The plants are dropped near the marks by a boy who keeps not more than four plants ahead of setter. The setter straddles the row on his knees, thrusts the dibber into the ground four to six inches deep, pushes it forward and inserts the plant with his left hand before withdrawing the tool. Some firm the soil about the roots by thrusting the dibber into the ground four or five inches deep on the farther side of the plant and pulling it backward; others place both hands around the crown and press it downward; or it may be firmed with the feet. Ordinarily dibber planting is somewhat faster than spade planting, but the hole is small, and careless workmen

wad the roots; they should be trimmed shorter for dibber planting than for spade planting. Several types of home-made wooden dibbers are in use. A pole four feet long, sharpened to a wedge three and one-half inches wide at the lower and larger end, and the cutting edge lightly ironed, has been used somewhat on light soils. A mason's trowel with the point cut off is serviceable.

One of the best planting tools for heavy or gravelly soils is made from a hoe. The blade is narrowed to the shape of an adz about four inches wide and the handle shortened to fifteen inches. The setter works on his knees. The hole is opened at a slant and the plant is slipped back of the blade as it is withdrawn; enough soil rattles down to hold it in place. The hole then is filled by striking the hoe between the setter and the plant, and close to it, pushing forward at the same time and raising the handle a little. One man can set 3000 to 5000 plants a day. An ax with a crooked handle is used occasionally on very tight soils.

The common method of planting under irrigation is to run shallow furrows and irrigate in them. When the soil is dry enough to work, set a row of plants along the side of each furrow about four inches from the edge — never in the bottom of the furrow (Plate V). Then turn water into the furrows until the land is soaked. In very hot weather, let a small stream of water follow in the furrow close behind the planter. Occasionally it is more feasible to soak the land first and set the plants with dibber or spade when the soil is dry enough.

Planting machines and transplanters.

Several types of two-horse planting machines, such as are used in transplanting tobacco, tomatoes, cabbages,

sweet potatoes and celery plants, are used somewhat for strawberries when the acreage is large. One man drives, one or two others get the plants into shape for the droppers and another follows the machine in order to set foot on every plant and to reset any that were not planted well. A machine will set 10,000 to 20,000 plants a day. The grower is more independent of the weather, since the machine waters the plants as they are set. The main disadvantage is that the plants are not always set at the right depth. A machine may give as good results as hand setting and be somewhat cheaper, when a large acreage is to be set.

When home-grown plants are to be set, especially in midsummer or early fall, a hand transplanter may be useful. The transplanter is placed over a strong runner and pushed into the soil to the brim; then it is lifted, taking the plant and a ball of soil with it. The plant is pushed into the hole with an "ejector." At least a hundred transplanting cups are needed so that a wheelbarrow load of plants may be carried at one time. Transplanters are used only when the soil is moist. The plants suffer little check, and leaf pruning is unnecessary. Transplanters are useful for summer or fall planting in the home garden and for commercial growers who have a small area under intensive culture.

Potted plants are set by inverting the pot, jarring the soil loose with a sharp knock and setting firmly without breaking the ball of roots. The cost of setting layer plants in the field is about fifty cents a thousand. Ordinarily a man will set two to three thousand; some men set four to five thousand under favorable conditions. Two setters and one dropper should set five to seven thousand plants a day.

CARE AFTER PLANTING

If the soil is light, the field should be rolled immediately after setting; if heavy, do not roll. A heavy roller may injure the crowns. Whatever tillage is given should be shallow and not close to the plants. Shade frequently is provided for several days after setting, especially in Florida and the Gulf states, unless the weather is cloudy. Palmetto leaves placed almost horizontally over the plants furnish sufficient protection. A more common method is to throw a handful of short straw, pine needles or similar material over each plant and remove it in four or five days. In the North, plants set in the summer or early fall may need shade; lawn clippings, straw and brush are used.

In regions not served by irrigation, occasionally it may be necessary to water plants recently set. This is best done in late afternoon and evening. A shallow basin is made about the plant to hold the water. After the water has soaked away the soil should be drawn back.

A few plants should be heeled in at the end of the rows when setting a field; these are used to fill the misses. When plants are scarce or expensive the first runners can be layered into pots and these potted plants used to fill the misses. Blossoms that appear soon after the plants are set should be removed, preferably before they open. The whole fruit stalk, not merely individual blossoms, is cut or pinched off close to the crown. If the blossoms are allowed to mature fruit, they exhaust the plant and delay the formation of runners. Except when the plants are grown in hills, it is desirable to have the runners start early. In the North, if the spring crop of blossoms is

removed, none others appear, except on everbearing varieties. In the South, especially in Florida and southern California, the plants blossom more or less continuously; how long to remove the blossoms depends upon the strength of the plants and when the crop is desired.

CHAPTER III

ROTATIONS, MANURING AND FERTILIZING

USUALLY, strawberries are grown in short rotations. Throughout the North, the plants rarely occupy the ground longer than fifteen months; in many parts of the South, barely half a year. The nature of the other crops in the rotation, and the treatment given them, determine the fertilizer treatment of strawberries fully as much as the native fertility of the land and the demands of the strawberry crop itself.

In early years, strawberries almost invariably were planted on virgin land. This is still done whenever practicable, especially in the South. Land which is planted to strawberries year after year becomes "strawberry sick." Heavy annual applications of manure or green-manuring will prevent this, to a large extent. The Seth Boyden farm, of about nine acres, at Hilton, New Jersey, has been in strawberries almost continuously for over fifty years, yet still produces undiminished crops with heavy manuring. Land that had "berried out" was common in the older shipping districts of Florida until the growers resorted to green-manuring. In Missouri and Arkansas, land that has been in strawberries for three or four years should not be set again for at least four years. Along the Atlantic coast, the crop may recur at shorter intervals since but one crop is taken from most plantings. In irrigated regions, if strawberries follow

strawberries, the second planting may need fertilizing. The strawberry crop lends itself readily to association with other crops. It occupies the land but a comparatively short period; it is of a low habit; the plants may be restricted to a limited space; and the fruit ripens in early spring, making it possible to plow the vines under and plant summer or fall crops.

Crops grown with strawberries are of two general types: rotation crops, those that are a part of a definite scheme of succession, usually including one or more that are introduced to improve the fertility of the land; and companion crops, those that are grown in association with strawberries merely as a matter of convenience, or to secure the fullest use of the land.

ROTATION PRACTICE IN DIFFERENT REGIONS

Very few growers follow a definite rotation. The exigencies of the season, market conditions and expediency in other respects frequently make it necessary to modify the plan. When virgin ground can be secured, it is preferred. If it is necessary to use old ground, most growers endeavor to precede strawberries with some other crop for at least two years. If one of these is a green-manuring crop, and the crop immediately preceding strawberries is one that will cleanse the land of weeds, so much the better.

In the North.

The most common rotation throughout the North is red clover, Irish potatoes and strawberries. This lasts three or four, occasionally five, years. A one or two year old clover sod, preferably top-dressed with manure, is

turned under for potatoes. After these are dug, crimson clover, rye or hairy vetch is seeded as a cover-crop. This is plowed under in winter or early spring for strawberries. Rye, heavily manured, is especially valued in Massachusetts for preceding strawberries. If the land is in urgent need of humus, cowpeas or soybeans may be seeded on the clover farrow and plowed under in the fall; then the land is manured and set to strawberries the following spring; or it is seeded to rye or crimson clover for spring plowing. Another popular plan is to manure a grass sod heavily, turn it for Indian corn, and set strawberries the year following. It is best not to plant on any kind of sod except, perhaps, a red clover sod, because of the difficulties with white grub, and undecayed vegetation.

F. E. Beatty recommends the following treatment on the sandy soils of Michigan. Seed rye in the fall and top-dress it with fifteen tons of manure an acre during the winter. Turn this in the spring for early potatoes, using about five hundred pounds an acre of a 4–8–9 fertilizer. If the potatoes can be harvested by July first, seed the land to cowpeas; if delayed until August first, seed Canada peas, since these are not hurt by early frosts. If the peas mature early enough, turn them under and seed rye again; if not, let them remain on the surface and disk them under in early spring before the strawberries are set. Hairy vetch is an excellent crop to precede strawberries on sandy soils. W. W. Farnsworth, of Ohio, recommends a three-year rotation, as follows: "As soon as the strawberry crop is harvested, plant Irish potatoes. After these are dug, seed rye. Very early the following spring seed red clover on the rye and harrow it in. Harvest the rye, plow under the

clover during the following winter, and plant strawberries in the spring."

When the area is very limited and it is desired to keep half of it in strawberries each year, Matthew Crawford, of Ohio, advises that buckwheat be seeded after the crop is harvested. This is plowed under and followed with rye, which is turned early enough in the spring to set strawberries. Cowpeas might be substituted for buckwheat in the South.

In the South.

The long growing season of the South makes it possible to introduce more soil-improving crops, and thus shorten the rotation. One of the best methods of quickly improving poor land in Delaware and Maryland for strawberries, is to sow cowpeas in May, plow them under in early August and follow with crimson clover. This land is ready for strawberries the next spring. If possible, a crop that cleans the land of weeds, such as Irish potatoes, sweet potatoes or tomatoes, should precede strawberries. If the potatoes are harvested too late to seed crimson clover, rye may be substituted. C. A. McCue, of Delaware, suggests this rotation: "First and second years, strawberries; third year, strawberries followed by crimson clover or cowpeas; fourth year, crimson clover turned under and land set to tomatoes, sweet corn or snap beans. At the last cultivation of these crops seed twenty pounds of crimson clover an acre, or hairy vetch. The fifth year the land may come in strawberries again; thus they occupy the land three years out of four."

In the Ozark district, a frequent result of plowing under red clover is a big volunteer crop; hence, clover

is not popular in a strawberry rotation. Cowpeas and rye are preferred. In the South Atlantic and Gulf states the cowpea is the main dependence of the strawberry-grower for improving his land. Usually, it is best to follow cowpeas with rye, oats or Indian corn, after which another crop of cowpeas may be turned down before planting strawberries. Cowpeas may be sown as a catch crop between the rows of corn at the last working. Velvet beans sometimes are used instead of cowpeas in Florida and the Gulf states. Caution is necessary about turning under a heavy crop of green herbage just before planting. It may be mowed and left on the ground for ten days, then cut into the soil with a disk harrow.

A large proportion of southern strawberries are grown in rotation with truck crops. Field corn, millet or winter vegetables, especially spinach, cabbage or kale, are planted after the old bed is plowed under. The next spring, vegetables are planted — commonly Irish potatoes — followed by a green-manuring crop of cowpeas. Then strawberries are set, or the land may go into corn with a cowpea catch crop and planted the next year. Another popular rotation is to seed cowpeas after strawberries, and either turn them under or make them into hay. Early cabbages or early potatoes follow. At this point another crop of cowpeas is taken off, or fall vegetables may be planted. The third year corn is planted, with a cowpea catch crop, and both vines and corn stalks are plowed under for strawberries. Other combinations of strawberries with truck crops are given on pages 49 and 50.

In the irrigated regions of the west, alfalfa is considered a good crop to precede strawberries, but it is difficult to kill out the alfalfa roots. In western Oregon and Wash-

ington, depleted land is brought into condition with one or two green-manuring crops of winter vetch, followed by some tilled crop the year before strawberries are planted.

COMPANION CROPS

The low habit and restricted growth of the strawberry plant makes it possible to grow many kinds of crops with it, not primarily to improve the soil, but in order to occupy all of the land. This is practiced mainly by market-gardeners and orchardists; it is not common in general field culture.

Vegetables used as fillers between strawberries.

In most companion cropping, vegetables are used which are harvested before the strawberries need the entire use of the land. Irish potatoes have been used largely for this purpose, especially in the Central and Southern states. In the Norfolk district, potatoes are planted in February, in rows five feet apart. Extra early varieties are used, especially Irish Cobbler. As soon as the potatoes have sprouted enough to mark the rows plainly, strawberries are set midway between (Plate III). The potatoes are dug about June first. On Long Island, potatoes are dug about July 10th, and snap beans, cabbages or turnips are planted in the same place. The strawberries may be set in rows three feet apart each way, with a hill of early potatoes between each two plants. The strawberries are not allowed to run until the potatoes are dug.

Early dwarf sweet corn, pop-corn and early maturing dwarf varieties of field corn, are used as companion crops in the Northern and Central states. The strawberries are

set in rows four feet apart and the plants spaced two feet apart in the row. A hill of corn is planted in each interval in the row. Unless the season is very dry, the corn does not injure the strawberry plants materially. The stalks are cut as soon as the ears are pulled.

In the Norfolk district, early maturing and small-headed varieties of cabbage, of the Wakefield or Early Sunrise type, are set in late fall or early winter in rows two and one-half feet apart. The following spring, strawberries are interspersed, as shown below:

C S C S C S C S
C C C C C C C C
C S C S C S C S

The cabbages are cut about the last of May and the entire area given to strawberries; or snap beans may be planted. Cabbages are less desirable than potatoes, because they shade the strawberry plants. Break down the outer leaves of the cabbage plants that are next to strawberry plants.

Tomatoes are valued as a companion crop, especially in Maryland, Delaware and New Jersey. The runners set freely underneath the tomato vines and are not smothered, as may be the case with cabbages. The spraying that is given tomatoes is beneficial to the strawberries, also. Strawberries are set in early spring, in rows four to five feet apart, the plants two feet apart in the row. In June a tomato plant is set in the center of each square, thus:

S S S S S
T T T T
S S S S S

Some prefer to alternate the strawberry plants and the tomatoes in the same row. Snap or string beans, onions, beets, peas, lettuce, radishes and other vegetables are grown between rows of strawberries occasionally.

Strawberries as fillers between fruit-trees.

The use of strawberries between fruit-trees is most common in the irrigated sections of the Northwest, between rows of apples and peaches (Plate III). It is better to leave each row of trees in an unplanted and tilled strip of land from six to ten feet wide. In the Yakima Valley, Washington, strawberries are used as fillers in peach orchards for three years, and in apple orchards for six years. Care must be taken not to injure the trees by the late irrigations that are necessary for strawberries, especially the first season. In humid regions, strawberries require tillage later in the season than is best for tree-fruits. They should be used in the orchard only the first two or three years and kept some distance from the trees. Occasionally, strawberries are grown successfully between rows of grapes, currants and gooseberries. The results from companion cropping will be disappointing unless the land is rich enough to support both crops and is tilled intensively. There is a double drain upon soil moisture and fertility.

PLANT-FOOD REQUIREMENTS

The strawberry is not an exhaustive crop. The slight amount of plant-food in the berries is shown by the analyses of L. L. Van Slyke:[1]

[1] Bul. 265, N. Y. (Geneva) Exp. Sta. (1905), p. 227.

TABLE I. — PLANT-FOOD IN STRAWBERRIES

		MOISTURE	NITROGEN	PHOSPHORIC ACID	POTASH
Beder Wood —	Berries	90.89 %	.149 %	.030 %	.254 %
	Hulls	79.57	.355	.086	.406
Gandy —	Berries	89.30	.133	.065	.246
	Hulls	81.83	.229	.065	.407
Sharpless —	Berries	90.27	.113	.057	.185
	Hulls	82.42	.246	.114	.376

Plant-food withdrawn from the soil.

The strawberry draws little plant-food from the soil as compared with a crop of corn or wheat. L. L. Van Slyke estimates that the approximate amounts of plant-food constituents used in producing a crop of 5000 pounds an acre, are 7.5 pounds of nitrogen, three pounds of phosphoric acid and twelve pounds of potash.[1] A wheat crop of thirty-four bushels an acre with straw included, removes about thirty-eight pounds of nitrogen, thirteen pounds of potash and nineteen pounds of phosphoric acid. This withdrawal of plant-food is very small compared with the total quantity present in ordinary soils. One of the best strawberry soils in Missouri, according to W. L. Howard, contains, in the top seven inches, 3800 pounds of nitrogen, 1430 pounds of phosphorus and 7990 pounds of potash.[2] A large proportion of this is not immediately available, hence strawberries on this soil profit by an application of 300 pounds of acid phosphate an acre, according to experiments conducted by the Missouri Experiment Station.

[1] "Fertilizers and Crops," p. 694.
[2] Report Mo. Hort. Soc., 1907, p. 267.

Why strawberries require a rich soil.

Although the amount of plant-food actually removed by the strawberry plant is small, the crop responds to liberal fertilizing. This is partly because it has a high money value an acre, — prospective, at least, — but chiefly because of the very short time between the blossom and the ripe fruit. In the North, the plants have only about four weeks in which to develop a crop that may weigh three or four times more than the plants. The apple has several months in which to mature its fruit, a large crop of which is not nearly equal to the weight of the trees. Hence, the main fertilizer requirement of the strawberry is that the plant-food shall be immediately available. The texture of the soil and the facility with which water and plant-food move through it are even more important than its plant-food content. Where the strawberry blossoms and fruits continuously over a period of several months, as in Florida and southern California, the draught upon the soil is somewhat heavier.

Numerous field experiments have shown conclusively that the analysis of the fruit is no index to the fertilizer treatment that should be given. Neither does an analysis of the soil reveal much that will aid the strawberry-grower in the use of fertilizers. The grower may obtain some hint from soil analyses and fertilizer experiments elsewhere, upon the same type of soil; but field tests with different fertilizers on his own farm are likely to yield more valuable results.

Results of fertilizer experiments.

The futility of attempting to follow the fertilizer practice of another district is illustrated by the conflicting

results secured in three representative experiments, in different parts of the country. In 1903–1904 the Tennessee Experiment Station conducted experiments at Knoxville "designed to show the effect of muriate of potash, acid phosphate and cotton-seed meal, singly and in various combinations, upon strawberries." [1] The conclusion was reached "This soil does not need fertilizer for strawberries." The Missouri Experiment Station has reported the results from fertilizers applied to a two year old bed at Sarcoxie, Missouri, in March, 1911.[2] These experiments indicate a marked benefit from the application of phosphoric acid, but a loss from the use of fertilizers containing potash and nitrogen. In 1901 the New York (Cornell) Experiment Station summarized the results of fertilizer experiments with strawberries in Oswego County.[3] These showed "the superiority of potassic and phosphatic fertilizers as compared with the nitrogenous."

The most profitable use of fertilizers depends not only upon the type of soil, its native plant-food content, physical condition and previous treatment, but, also, on the variety, method of training, age of plants, distance from market and methods of culture. Varieties like the New York cannot stand a very rich soil; the foliage becomes so rank that the fruit-stems and the berries mould. Hill plants require heavier fertilizing than matted rows. The older the plants, the more they respond to fertilizing. When strawberries are grown at a great distance from the market, and firmness is most important, nitrogen must be applied sparingly, if at all. Under intensive

[1] Bul. Tenn. Exp. Sta., Vol. XVIII, No. 2, p. 13.
[2] Bul. 113, Mo. Exp. Sta. (1913).
[3] Bul. 189, N. Y. (Cornell) Exp. Sta. (1901).

culture and on high-priced land, as in trucking and market-gardening, an amount of fertilizer can be used profitably that would be impracticable in general field culture. For these reasons, general advice concerning the use of fertilizers is of little value. It is a local and personal problem.

GREEN-MANURING

Green-manuring is beneficial chiefly because it improves the physical condition of the soil through the addition of decaying vegetable matter, which becomes humus. Leguminous green-manuring crops, such as the clovers and cowpeas, also may enrich the soil with nitrogen, accumulated through the nodules on their roots. No green-manuring crop adds to the soil any more potash or phosphoric acid than it took out. If the soil is deficient in these plant-foods, therefore, it is necessary to supplement green-manuring with applications of the mineral plant-foods. Heavy applications of nitrogenous manures and fertilizers tend to make soft berries. This difficulty is largely overcome by the free use of leguminous green-manuring crops in the rotation. Except when large quantities of barn manures are available at a low price, green-manuring is the most practicable method of keeping the soil in good heart. The use of green-manuring crops in strawberry rotations is considered on pages 45 to 49.

FARM MANURES

For many years, farm manures, especially horse manure, were used in North America almost to the exclusion of other fertilizing materials. Nearly all the unfavorable

results reported from the use of manure, such as running to vines, poor flavor and lack of firmness, are caused by the large amount of available nitrogen that it contains. One ton of fresh horse manure contains about 9.8 pounds of nitrogen, 3.1 pounds of phosphoric acid and 14.9 pounds of potash. This is not a balanced fertilizer for the strawberry; it contains too much nitrogen in proportion to the mineral plant-foods. On clay soils, which are usually rich in available potash and phosphoric acid, manuring alone may give excellent results; but in most cases it is desirable to supplement manuring with applications of potash and phosphoric acid. Another disadvantage, especially with horse manure, is the large number of weed seeds that it contains. This may be overcome, in part, by composting the manure. If fresh manure is used, it should be applied to the preceding crop at least a year before strawberries are set. Very strawy manure should not be applied at planting time, as it loosens and dries out the soil. The disadvantages of manure are insignificant compared with the benefits. The plant-foods in manures are readily available: they contain bacteria which have a beneficial influence on soil fertility; they increase the water-holding capacity of the soil and improve its texture; the beneficial effect is extended over many years.

Rate of application.

In most cases, manure should not be used as a main source of plant-food, but in connection with green-manuring and commercial fertilizers. The application to the acre will depend largely on the cost; when manure costs over two dollars a ton perhaps the same results can be secured at less expense with green-manures and commercial fertilizers. An application of twelve to

twenty tons an acre is considered sufficient on average soils. Market-gardeners close to city stables, where manure can be secured for fifty to seventy-five cents a ton, make very heavy applications. Henry Jeroleman, of New Jersey, uses "at least sixty one-horse loads of manure to the acre each season."

Manure is broadcasted and harrowed in; this is preferable to plowing it under, unless it is very strawy. Non-heating kinds, as cow or hog manure, may be scattered in the planting furrow. Only about one-half to one-third as much poultry manure should be applied to the acre as of horse manure. If used as a top-dressing on growing plants, it is likely to burn the foliage. For this purpose, mix one part of manure with three parts of soil or muck.

Use of lime and ashes.

The wild strawberry plant thrives in acid soils. Many cultivators have observed that the domestic varieties are somewhat impatient of lime. In 1912, W. J. Wright reported experiments in Pennsylvania which showed the superiority of unlimed soil.[1] A Florida grower advises: "Never use lime or land plaster; it is poisonous to the strawberry." On the other hand, F. E. Beatty cites experience in Michigan, Indiana and Iowa, which shows that moderate liming of acid soils is quite beneficial.[2] It is evident that lime should be used sparingly if at all, unless needed to secure a maximum growth of the legumes in the rotation.

Unleached wood ashes once were used extensively. They were harrowed in before planting at the rate of

[1] Proc. Sci. Hort. Sci., 1912, pp. 9–14.
[2] Market Growers' Journal XI (1912), p. 266.

twenty-five to one hundred bushels an acre, or used as a top-dressing in the fall or early winter. The results were variable, partly because a ton of wood ashes contains about 600 pounds of lime. When ashes can be bought at a reasonable figure they can be used to advantage on all soils not well supplied with lime. Ashes should not be mixed before being applied with any organic material, such as hen manure, as they will liberate the nitrogen in the manure.

APPLYING FERTILIZERS

When the plants grow a full year before bearing, most of the fertilizer is applied the first year, in order to secure strong crowns.[1] Little, if any, fertilizer is applied the second year, unless the field is to be renewed; in which case it is fertilized immediately after the surplus plants have been removed. A large number of growers in the Northern and Central states apply one-third of the fertilizer before the plants are set, one-third during the summer and one-third early the following spring, before the plants have started to grow. The third that is used during the growing season frequently is divided into several applications; small handfuls are dropped between the plants, at intervals of three to four weeks, and hoed in. When the plants begin to slacken in growth, they will be benefited by a fertilizer stimulant.

In the North, many growers have had satisfactory results from nitrogenous fertilizers applied very early in the spring of the fruiting year. The gain is due mainly to the larger size of the fruit; the number of berries is

[1] The sources of plant-food in commercial fertilizers and the home mixing of fertilizers are discussed in "Fertilizers," by E. B. Voorhees, Revised Edition, 1916. Rural Science Series.

increased but little.[1] Gains of 500 to 1000 quarts an acre from a spring top-dressing of nitrate of soda are not infrequent. It is applied as the plants come into bloom. If used late in the spring, there is danger that it will produce a rank growth and the berries will be soft and of poor quality and flavor. This danger is greater in the South than in the North. Varieties that are weak in vine growth, like the Clyde, respond best.

Experiments in southwest Missouri by W. H. Chandler yielded the following results:[2] "Nitrogen in the form of either sodium nitrate or dried blood, when applied in the spring before the crop is harvested, has, in every case, given very injurious results. It causes excessive plant and weed growth and greatly reduces the yield of the fruit. While the berries are larger, there are fewer of them, they are soft, and they have poor color and quality." In Florida and the Gulf states it may not be practicable to apply nitrogen at any time, as it makes the berries soft. Throughout the South, three or four applications of fertilizer commonly are made; the first when the plants are set, and the last four or five weeks before the plants bloom.

Methods of distributing fertilizer.

The roots of the strawberry do not forage much beyond the spread of the leaves. When quick action is desired, the fertilizer must be placed close to the roots, if 1000 pounds or less are applied at one time; larger applications are broadcasted. Furrows may be opened where the rows of plants are to stand, and a bull-tongue used to mix the fertilizer with the soil before setting the

[1] Report N. J. Exp. Sta., 1891, p. 141.
[2] Bul. 113, Mo. Exp. Sta. (1913), pp. 304–5.

plants. Where the land is bedded, the bed is split with a bull-tongue, the fertilizer sowed, and a double shovel used to mix it with the soil before the plants are set. Some scatter fertilizer in the bottom of a furrow, then turn additional furrows upon it from each side to make a drainage bed. Usually, it is more convenient to set the plants first and make side applications of fertilizers afterward. A shallow furrow is turned away from the row, the fertilizer scattered in it and the soil thrown back. But one side of a row is opened at a time. Many Florida growers put all the fertilizer in with the hoe. Three men work together; one opens a hole between two plants with a single stroke of the hoe, another drops the fertilizer and a third pulls the soil back over it. There are a number of horse-pulled fertilizer distributors adapted for use in broadcast training. These have a fan-shaped arrangement on each side which broadcasts fertilizer over each row. Chemical fertilizer, ashes, and particularly nitrate of soda, should not be used as a top-dressing when the plants are wet, even if dormant, as they are likely to burn the foliage. If it is raining, however, the fertilizer can be applied without danger. If fertilizer is applied as a top-dressing when the plants are dry, run a brush drag over the rows to remove any that clings to the leaves. If the top-dressing is less than 150 pounds an acre, the fertilizer should be mixed with an equal quantity of dry soil, so that it may be distributed more evenly. In Oregon, the spring top-dressing of nitrate of soda sometimes is applied in solution, at the rate of one ounce to three gallons of water. About one pint is poured around each hill plant.

CURRENT FERTILIZER PRACTICE

Fertilizer practice for strawberries, as for other crops, depends greatly on the soil and other factors; but the plant, being shallow-rooted, responds readily to fertilizers as a rule, if the land is in need. Various geographical practices or tests are here recorded.

Canada and northern United States.

In this region the main dependence is farm manures. H. F. Hall of New Hampshire recommends a choice of one of these three treatments:[1]

"1. Fifteen to eighteen cords of stable manure per acre.

"2. When manure is scarce, eight to ten loads of manure supplemented with seventy-five bushels of unleached hard wood ashes and 600 pounds of fine ground bone, harrowed in before the plants are set.

"3. When no manure can be obtained, use 1500 to 2000 pounds per acre of the following fertilizer; broadcast all of it and harrow it in before setting the plants: 100 pounds nitrate of soda; 500 pounds tankage; 1000 pounds acid phosphate; 400 pounds muriate of potash. This fertilizer analyzes 2.5 per cent nitrogen, 10 per cent phosphoric acid, and 10 per cent potash. In addition to the above treatment, top-dress with 100 to 200 pounds of nitrate of soda when the plants are in bloom, to increase the size of the fruit."

L. H. Bailey reported on a three-years test of fertilizers in Oswego County, New York, as follows:[2] "These experiments show the superiority of potassic and phosphatic fertilizers as compared with the nitrogenous. The nitro-

[1] Bul. 137, N. H. Exp. Sta., pp. 160–1.
[2] Bul. 189, N. Y. (Cornell) Exp. Sta. (1901), p. 128.

gen fertilizers, including very heavy applications of stable manure, gave too much growth and an inferior quality of fruit." For western New York, L. J. Farmer recommends 500 to 2000 pounds of a 4–10–10 fertilizer (that is, one analyzing 4 per cent nitrogen, 10 per cent phosphoric acid and 10 per cent of potash). In the market gardens near Boston, very heavy applications are made. In 1908, Wilfrid Wheeler, of Concord, Massachusetts, recommended, "At the first feeding, which should come about two weeks after setting, use tankage analyzing 7 per cent of nitrogen at the rate of one ton per acre. Follow this two weeks later with either ground bone or bone black at the rate of 1800 pounds per acre. One week later, apply one ton of wood ashes per acre. Another application of bone, and later one of bone black, will greatly help the plants." In addition, he often used 200 pounds of nitrate of soda in early spring. These recommendations are for hill plants in market gardens, when a yield of about 20,000 quarts to the acre is expected.

Middle Atlantic states.

In 1901 E. B. Voorhees, summarizing the results of four years' experiments in New Jersey, advised the use of 500 to 800 pounds of a mixture of raw ground bone, acid phosphate and muriate of potash, equal parts by weight, to be applied broadcast before the plants are set; followed by fifty to sixty pounds of nitrate of soda or dried blood before they start to grow, and a top-dressing of 100 pounds of dried blood in early spring. At Hammondton, New Jersey, the growers now use 500 to 1000 pounds an acre of a 5–8–10 fertilizer. Another popular mixture is 400 pounds of dried blood, 1200 pounds of bone meal, 400 pounds of sulfate of potash, applied at the

rate of 600 to 1200 pounds an acre. Delaware and Maryland growers use 500 to 2000 pounds an acre of a 2–8–10, 3–7–11, 3–9–7 or 4–6–14 fertilizer during the first season, sometimes followed with a spring top-dressing of nitrate. Four hundred to 500 pounds are applied at planting time, and an equal amount in midsummer, late summer, and early the following spring.

South Atlantic states.

In the Norfolk district, strawberries are grown with truck, and the fields are manured heavily. In addition, from 1500 to 2000 pounds of high-grade complete fertilizer are used to the acre annually. Frequently the expense for fertilizing an acre is seventy-five dollars a year, of which thirty-five is for manure and forty for fertilizers. Only a part of this is charged to the strawberry crop, since two vegetable crops are harvested from the same land in one year. Most of the fertilizer is applied to the companion truck crops. Poor results from the use of nitrogenous fertilizers begin in North Carolina, and become more acute farther south, as the distance from market increases. On the sandy soils of the coastal plain of North Carolina, a 3–8–10 fertilizer is used almost exclusively. From 1200 to 2000 pounds are applied, half in July or August, and half in December or January. On the heavier soils, 500 pounds of raw bone or dissolved bone are applied two or three weeks before the plants are set, and again in the fall.

Southern states.

Very little manure is used in the South, because it softens the fruit. For the same reason, nitrate of soda should not be applied for three months before shipping

begins. In many parts of the South, especially in eastern Tennessee and Alabama, strawberries are grown wholly on new ground and no fertilizer is used. Florida growers fertilize heavily. About 1890, applications of two tons an acre of high-grade fertilizer costing sixty-five dollars, were common. Now, the maximum is about one ton, costing forty dollars and analyzing 3 to 4 per cent nitrogen, 6 to 8 per cent phosphoric acid and 6 to 8 per cent potash. On very sandy soils the proportion of potash is increased to 10 or 12 per cent. The most popular mixture in Florida is 800 pounds cottonseed meal, 800 pounds acid phosphate and 250 pounds muriate of potash. From 400 to 1000 pounds of fertilizer are applied in the furrow, when the plants are set. Some prefer to wait until six weeks after planting and give a side-dressing. Another side-dressing is given four to six weeks later, on the opposite side of the row; and in November or December a third application, directly between the plants in the row.

About the same methods are used in Georgia and Alabama as in Florida. A 4–8–8 fertilizer is popular, but nitrate of soda is preferred to cottonseed meal. Most of the clay soils of Mississippi and Louisiana are abundantly supplied with potash, but it is well to use some potash, even on the clay soils, as it gives firmer and brighter berries. From 400 to 800 pounds an acre of a fertilizer analyzing 4 per cent of nitrogen and 6 per cent of phosphoric acid, are most commonly used; on sandy soils, 4 to 6 per cent of potash is added. In Mississippi and Louisiana it is customary to apply one-half of the fertilizer in June or early July and the balance in the autumn.

Most of the soils in the Ozark region are somewhat

deficient in nitrogen and phosphoric acid but applications of fertilizers after the plants are established give poor results. It is preferable to maintain the nitrogen content by the use of green-manures. W. H. Chandler recommends that on all but the richest soils 250 to 300 pounds of acid phosphate or steamed bone-meal be used, preferably one year before the crop is harvested, and that no nitrogen or potash be applied.[1]

Very little fertilizer is used west of the Mississippi Valley, and almost none in the irrigated districts, unless the land is cropped in strawberries continuously. Some Oregon growers use a mixture of three parts wood ashes to one part ground bone, and a 3–6–9 fertilizer is used occasionally, at the rate of 500 to 800 pounds an acre, especially on the older beds.

[1] Bul. 113, Mo. Exp. Sta. (1913).

CHAPTER IV

TILLAGE AND IRRIGATION

TILLAGE is more beneficial to the strawberry than to most other fruits; it is not able to cope successfully with weeds, because of its low habit of growth. A rank growth of weeds smothers the plants, cutting them off from sunshine, water and plant-food. Moreover, the proportion of the fruit to the plant is very large and about nine-tenths of the berry is water.

WHY TILLAGE IS ESSENTIAL

One reason why the strawberry plant requires a large quantity of water is because it is shallow-rooted. In 1883 E. L. Sturtevant washed out the roots of a Triomphe plant growing on heavy clay soil at Geneva, New York, with the following result: "The roots extended nearly vertically downward to a depth of twenty-two inches. The horizontal roots were few and short, the longest being traceable but six inches. Nearly all the fibrous roots were found directly beneath the plant." In 1896 E. S. Goff washed out the roots of a section of a matted row, two feet wide, growing at Madison, Wisconsin. He reported: "The deepest roots extended a little less than two feet, while the horizontal roots only extended three inches on either side, reaching scarcely beyond the area covered by the leaves. The roots grew largely down-

ward, and all but the merest fraction of them were contained within the first foot of soil."[1] The soil was a light clay loam overlaying a sandy clay subsoil. In the same soil the roots of raspberries extended five feet deep. These observations show why the supply of water and plant-food must be abundant and quickly available.

Weeds.

Few persons would till a strawberry field as thoroughly as it should be, in order to conserve soil moisture, without the incentive of weeds. Weeds are tangible and concrete evidence that the soil needs attention. Something may be done to lessen the number of weeds by selecting a clean field for planting and not using fresh manure. The most troublesome weeds in the strawberry field are purslane, crab-grass and chickweed. Purslane and crab-grass are summer weeds, and exceedingly tenacious of life. Some southern growers make the best of a bad situation by letting crab-grass grow after midsummer and use it to mulch the berries. Chickweed is a cool weather plant; it makes most of its growth during late fall, winter and early spring, while the crop is laid by. Where the winters are mild, as along the South Atlantic seaboard, it is a serious nuisance. A field that apparently was quite free from weeds when laid by in the fall may be a mat of chickweed in the spring; not infrequently, such fields are plowed under, as not worth picking. Spraying chickweed with iron sulfate gives fair results, but costs too much. L. J. Farmer, of New York, prescribes the following treatment: "If mouse-eared chickweed or other fine weeds come late in September or early October,

[1] Rep. Wis. Exp. Sta., 1897, p. 289; Rept. Wis. Hort. Soc., 1896, p. 250.

the simplest method of destroying them is to loosen up the soil between the rows with a cultivator and then haul this with a common hoe right up upon the row of plants, covering the weeds and runners and small plants with one inch of soil. The young strawberry plant will grow up through, but most of the weeds will be smothered, and the ones that lie over until spring can be pulled out by hand."

A straw mulch is used successfully as a substitute for tillage in hill training and under intensive culture. John Knox, of Pittsburg, Pennsylvania, the "strawberry king" of 1861, grew his fifty acres of hill plants in this way. In the "Kevitt system" the plants are tilled the first season, but mulched thereafter. Layer or potted plants set in late summer or fall are commonly mulched when planted, and no tillage given until after the crop is harvested the following spring. Summer mulching is not practicable in regions having a very severe winter; it makes the plants tender, and they are likely to be winter-killed unless an additional winter mulch is applied. The Arizona Experiment Station found that in the hot, arid climate of southern Arizona it is advantageous to mulch with fine straw about the middle of June to keep the roots cool. With these few exceptions, strawberry plantations are tilled, and much more thoroughly than was once thought necessary. Few modern fields are as weedy as those described by J. R. Warder in 1864, as yielding "two tons of hay and one ton of strawberries per acre."

TILLAGE TOOLS

Perfectly straight rows are not only a pleasure to the eye but also a distinct aid to thorough and economical

tillage. If the plants are aligned both ways, the cultivator can be run both ways within three to four inches of the plants, and but little hand hoeing, which costs more than horse tillage, is necessary. Since the roots seldom extend beyond the spread of leaves, there is little danger of working too close, provided the tillage is shallow. Close planting and hand tillage with the wheel hoe are practiced commercially in Florida and southern California; also, to a limited extent, in the market-gardens of the North Atlantic states and in home gardens. There is a steady drift away from hand tillage, especially in Florida. Except where forage and grain are quite expensive, horse tillage costs less than hand tillage and is more satisfactory, even though fewer plants can be grown on an acre.

Tools for horse tillage.

The best tillage tool is the one that will do the work required of it at the least expense. The tool that suits one man and one set of conditions may be inappropriate elsewhere. Frequently a weeder is used two or three times immediately after the field is set. It does not pull up the plants, if they were set firmly, and makes a shallow mulch. After the plants are firmly rooted, cultivate rather deeply, so as to loosen the soil that was tramped in setting the field. This is especially necessary on heavy land. A five-toothed cultivator with broad shovels is used for this purpose. This implement is likely to ridge and dry out the soil; hence a ten- or twelve-toothed cultivator, with narrow shovels or spike teeth, is preferred for summer tillage unless the soil is wet. A two-horse sulky cultivator covers about seven acres a day, a one-horse cultivator covers three and one-half acres. A two-row cultivator covering fifteen acres a day is used

somewhat in large operations. On very stony land the cultivator throws stones upon the plants; if it is run reversed, the gravel works toward the middles.

The toothed cultivator does not cut off large weeds. Four knives, made of heavy pieces of steel or a common wagon spring, may be attached to the cultivator. These slide over the ground and shave off the large weeds. If the outer teeth of the cultivator run too deep and throw soil upon the plants, they should be adjusted to work shallow, or may be removed entirely and wooden pegs substituted. In locations with sandy soils there is danger that heavy winds will blow sand upon the crowns and kill the plants. A tillage tool that leaves the surface ridged will prevent this in part.

Tools for hand tillage.

When the rows are set so close together as to require hand tillage, the wheel hoe is used (Plate IV); this is supplemented with the scuffle hoe, which shaves off at the surface all the large weeds that slip through the teeth of the wheel hoe and gives very shallow tillage. It is used for the first two cultivations of hill plants after they are set.

The hand hoe must be used more or less in all methods of training. The common garden hoe has too wide a blade for convenient use between and around strawberry plants. The blade should be narrowed to three inches and tilted slightly, so that it will work not over one-quarter of an inch deep. Some growers prefer a triangular hoe made by cutting off the blade of the common hoe from the shank to the outer and lower corners. Another popular type of blade is twelve inches long and two inches wide. Both are useful for working under the leaves and around the runners, especially in matted row training.

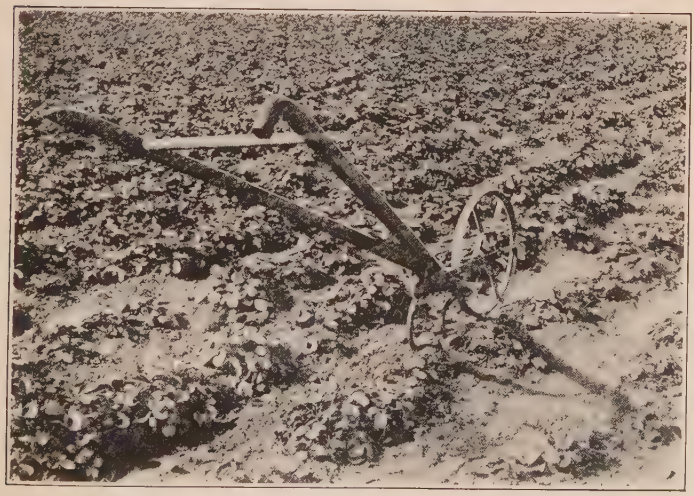


PLATE IV. TILLAGE. — *Top*, plants smothered by crab-grass, Norfolk, Virginia; *bottom*, wheel hoe, Los Angeles, California.

TILLAGE METHODS

The frequency of tillage depends on the nature of the soil, the annual rainfall, the time of the year and weather conditions. The necessity of keeping down weeds usually sets the pace, but soil moisture is an equally important guide. Some soils are dry and leachy; others hold moisture tenaciously. Gravelly soils with a clay subsoil hold moisture much better than tight clays, since the gravel acts as a surface mulch. Ten cultivations may be as effective upon this soil as four upon others. The best time to kill weeds is when they are sprouting. Three cultivations then cost no more than one after the weeds have become so large that they slip between the cultivator teeth and must be chopped off with the hand hoe. Some growers cultivate thirty times a season and give five hand hoeings. The average among good growers is fifteen cultivations and three hand hoeings.

The loss of water from an uncultivated strawberry field, by evaporation, is much larger than is commonly supposed. Soils that are packed and crusted by a rain lose water very rapidly. The crust should be broken as soon as the soil is dry enough to be worked. On light sandy soils do not begin cultivation until the plants are well established; early tillage causes the sand to drift over some plants and away from others.

Depth of tillage.

The nature of the soil and seasonal conditions determine the depth of tillage. Tight clay soils need deep tillage; sandy soils shallow tillage. In dry weather cultivation should be shallow; in wet weather deep. For ten days or two weeks after the plants are set culti-

vate shallow, if at all, so as not to disturb the plants. Be especially careful not to throw soil upon the crowns; unless it is soon removed by hand, at the first hoeing, the crowns will rot. After this, one or two deep workings should be given to loosen the soil compacted by the planters. In the North there is little danger of injuring them by deep working; in the South, apparently, there is some danger from deep tillage in the fall. Midsummer tillage should be shallow, — not more than two and one-half inches deep. It is well to vary the depth slightly and to use different types of tools; some growers alternate five-toothed and twelve-toothed cultivators throughout the season.

Usually it is best not to ridge the land with the cultivator any more than can be helped. The rows tend to ridge naturally if the field is fruited three or four years. Level culture, when practicable, is better than ridge culture, because it exposes less soil surface for evaporation. There are some sections, particularly in Florida and the Gulf states, where surface drainage must be provided. This ridging is usually done, however, before the plants are set. The other extreme is found in the lighter soils of New Jersey and the Delaware-Maryland peninsula; there some growers consider it an advantage to have the middles higher than the rows, so that surface drainage will be toward the plants.

In matted row and spaced row training the disposition of the runners must be taken into account when cultivating. The land can be cultivated both ways and close to the mother plants until early summer; then the cultivator must be narrowed gradually to permit the runners to root. Run the cultivator in the same direction each time; if reversed, many of the runners are uprooted.

Several hand hoeings are necessary to stir the soil close to the plants and destroy large weeds that have escaped the cultivator. Very large weeds that have rooted close to strawberry plants should be pulled only when the soil is wet, and with the feet set firmly on each side, or they may be shaved off at the surface.

How late to till in the autumn.

How late to till depends on the locality and the variety. Many northern growers stop the cultivator in early September, but the conviction is growing that it is better to continue tillage until the first severe frost, so that the field will go into the winter free from weeds. In the mild climate of the coast region of British Columbia, Washington and Oregon, weeds grow luxuriantly all winter; hence it is necessary to maintain tillage throughout the winter and until the plants blossom. In the Gulf states the field is commonly laid by about November, and, if necessary, several hoeings are given during the winter, the last one just before the plants bloom.

From tidewater Virginia southward, especially in the Norfolk district, it is customary to abandon the field to crab-grass after midsummer. The dense crop of crab-grass and other weeds that spring up after midsummer is mowed and left as a mulch; or, if chiefly crab-grass, it may be made into hay. In Florida and the Gulf states, this method is advised by many cultivators. "It is one of the strong points in successful strawberry culture in this latitude," says H. E. McKay of Mississippi. "Crab-grass, not being deep rooted or continuing its growth of top longer than early frost, does not materially interfere with the continued growth of the strawberry stools during the winter, even should their growth be

temporarily checked by the growing grass." It is evident that this apparently slip-shod method has real merit under certain conditions. It is inexpensive, and it gives early berries, but it precludes the possibility of producing a large crop, and there is danger that the grass will grow so thick that the plants will be smothered.

Varieties with tall, rank foliage, like the Gandy, should not be cultivated as late in the fall as varieties with scant foliage like the Clyde, unless this is necessary for weed or moisture control. The method of training and the dryness of the season will influence the decision to some extent. At the last cultivation run a narrow furrow, four or five inches deep, down each middle, so that surface water may be drained away from the plants quickly. As winter approaches, go over the field with a sharp-pointed hoe and pick out all weeds between the plants, so that they will be clean when laid by under the mulch.

Early spring tillage.

If the field has become very weedy during the winter, especially with mouse-eared chickweed and shepherd's purse, tillage in the spring of the fruiting year may be necessary. Spring tillage establishes a soil mulch; if the fruiting season is dry, this may be a decided benefit. Heavy clay soils, that bake and dry out easily, are benefited more by spring tillage than sandy soils. When growers depend on fruiting beds for plants to set new fields, spring tillage is useful to smooth the surface after digging the plants. The objections are the possibility of injuring the roots, and the expense. The danger of injuring roots by spring tillage has been greatly overestimated; most of the roots are directly beneath the plant and are not touched by the cultivator.

If a winter mulch is applied, the expense of spring tillage is heavy. The mulch is removed from the first row and placed on the adjacent land. The first row is then cultivated, the mulch on the second row placed upon it, and so on, from row to row, across the field. The mulch of the first row is carried to the last row. Some growers rake off all the mulch and cultivate the field several times; it is replaced before the berries begin to ripen. When the winter mulch is light and the plants are grown in hills or hedge-rows, the straw may be drawn close to the plants, leaving the middles free for tillage. Where five inches or more of winter mulch is used, spring tillage is rarely practiced; the expense is prohibitive. The mulch is left undisturbed, and any large weeds that push through it are pulled by hand when the ground is wet. C. P. Close reports experiments in Maryland during the seasons of 1908 to 1911, which showed an average loss of 188 quarts an acre from spring tillage, and only one year was it an advantage; this was in 1911, when the month of May was very dry. Where no winter mulch is used, it is customary to give shallow cultivation until the blossoms open. This practice prevails on the north Pacific coast and, to some extent, on the lighter soils of New Jersey, Delaware and Maryland. Spring tillage is common throughout the South, where no winter mulch is used. It retards the ripening period slightly; if this is a disadvantage, shave off the weeds with a sharp hoe.

Tillage during the blossoming period is not desirable. If the soil is dry, dust is thrown upon the blossoms, and results in malformed berries. Since tillage checks the radiation of heat as well as the evaporation of soil water, fields tilled when the plants are blossoming are perhaps somewhat more likely to be injured by frost. Some

growers cultivate through the picking season in order to loosen the ground compacted by pickers and preserve a soil mulch. This is practicable only when the soil is sandy and well drained; a heavy soil might become muddy and disagreeable to the pickers. It would help to prevent the berries from being spattered with dirt if a single narrow furrow is run through each middle to carry off the rainfall. In southern California, strawberries are tilled throughout the protracted blossoming and ripening period.

IRRIGATION IN ARID REGIONS

Irrigation is the handmaid of tillage; the main object of both is to maintain an adequate supply of moisture in the soil. In arid regions, irrigation of strawberries is indispensable; in humid regions it may be advantageous.

The methods of irrigation in common use are of two types, — gravity or pressure. Gravity irrigation is practiced in arid regions almost exclusively. The water is secured from a community irrigation ditch, a local stream, or an open or driven well. Sometimes engine-driven pumps are used to raise the water and impound it in reservoirs, from which it is distributed upon the land by gravity. In humid regions gravity irrigation is used somewhat, also, but the pressure or overhead spray system finds greater favor. Subirrigation, in which the water is applied beneath the surface through lines of tile, is not in common use, as it requires special conditions for success.

Land used for gravity irrigation should have a grade sufficient to move the water slowly, yet not be so steep that the soil will wash. A grade of two inches in a hundred

PLATE V. IRRIGATION. — *Top*, before setting, at San Diego, California; *center*, contour irrigation, Hood River, Oregon; *bottom*, double rows on an irrigation ridge, Watsonville, California.

feet is sufficient, but a grade of three and three-fourths inches in one hundred feet is permissible. Hillsides may be irrigated by running the furrows on contour lines, but this is an added expense and inconvenience (Plate V). A grade of six inches to a rod can be used in hillside irrigation if the flow of water is small. It is important that the water shall not come into direct contact with the vines or berries while the sun shines; this would cause scald. Bring the land to an even grade, otherwise the high places will be too dry and the low places too wet.

Methods of applying water.

On medium loams, irrigation is commonly by means of temporary furrows, laid off between the rows with a plow or scooter, and level culture practiced. Where the soil is rather heavy, as in the Pajaro Valley, California, the land is thrown into beds or ridges fifteen to eighteen inches wide, four to five inches high, and two feet apart. These irrigation ridges are made by throwing two furrows together and leveling with a drag. In seasons of heavy rains they provide surface drainage, as well. A row of strawberries is set on each edge of the ridge. The beds are high enough so that water does not touch the fruit. The water furrow is used to walk in, so as not to compact the soil around the plants. In Texas, double-row ridges are two feet wide and eight to twelve inches above the bottom of the water furrow. The distance between ridges is about three feet; this interval is tilled after irrigations. In southern California the plants are set fifteen to eighteen inches apart on low single-row ridges. The water may be turned into alternate furrows during the ripening season, so that one will be dry for pickers.

When the soil is so sandy or coarse-grained that water does not rise to the top of the ridge by capillary action, it is necessary to reverse the method. The plants are set in double rows about two feet apart and a low bank, or levee, is made on each side, with soil drawn up from the middles. The narrow strip thus enclosed is irrigated by flooding when the sun is not shining. When strawberries are trained in hills or hedge-rows, they are set in double rows, eighteen to twenty-four inches apart, and the irrigation furrow is run down the middle of each pair of rows. This leaves the interspaces dry for tillage and picking. If the rows are two and a half or three feet apart, the plants are set in single rows and there is one water furrow in each middle; if the interspace is wider, a water furrow is made on each side of every row.

Water is conveyed to various parts of the field through small ditches or flumes. Flumes are made of boards about ten inches wide and twelve feet long (Plate VI). A square flume is made by nailing together three boards, braced by strips across the top; V-shaped flumes, made of two boards, are used for a small flow of water. The flumes are laid upon low trusses or square blocks of wood. An inch auger hole is bored close to the bottom of the flume, opposite the middle of each row. Corks, wooden buttons or tin gates are used to close the hole when the water is not needed. Enough water should be diverted at one point to run quickly the entire length of the row, but no farther. The lateral ditches or flumes should be so distributed that the irrigation furrows will be short, usually not over 400 feet; if too long, the water does not run to the end quickly enough and the plants near the flume get too much water, while those at the end do not get enough.

How often to irrigate.

The effective and economical use of water is an art learned only by experience; book directions are of little value. The amount of water to use depends primarily on the annual rainfall of the locality and its distribution during the year; also, to a considerable extent, on the nature of the soil. At Watsonville, California, the annual rainfall is thirty inches, yet so little of this falls during the growing season that strawberries are irrigated every ten to fourteen days. Near San Diego, California, which is cloudless most of the year, strawberries are irrigated every three or four days throughout the protracted picking season of six to eight months. There are few localities where it is necessary to irrigate more often than once in two weeks, except while the fruit is ripening, when it is customary to irrigate as soon as possible after each picking, so that the soil will be dry for the next picking. Usually, irrigation is discontinued in the fall, about the time that strawberry-growers in humid regions lay by their fields. Where plants suffer from winter injury, an irrigation of two or three inches in late fall, just before the ground freezes, may be an advantage, as winter injury is most serious when the ground is dry.

Irrigation does not make tillage unnecessary. The ditches frequently get foul with weeds, and weed seeds are carried to the land in the irrigation water. Moreover, the soil needs to be stirred to prevent it from crusting, to promote aëration and to check evaporation. Except during the picking season, the middles should be cultivated after each irrigation. The most successful growers maintain soil moisture as far as possible with tillage and irrigate only enough to supplement this natural supply.

IRRIGATION IN HUMID REGIONS

The distinction between humid, semi-arid and arid regions is wholly arbitrary. A region having an annual rainfall of twenty inches or more is generally regarded as humid, provided this is well distributed throughout the year; if so, all ordinary farm crops can be grown. Usually, however, the rainfall is not well distributed; some months may be practically rainless. Under these conditions, supplemental irrigation may be profitable as an insurance against drought. The Hood River Valley, with an annual rainfall of thirty inches, illustrates the value of supplemental irrigation in a humid region. The summers of the Atlantic states, where commercial strawberry-growing is highly developed in connection with trucking, frequently are marked by protracted droughts. These may be so severe that most of the leaves die and the plants become practically dormant. When rains come the plants revive, produce a second crop of blossoms, and a fall crop is harvested.

Irrigation experiments in humid regions.

Experiments have yielded conflicting results, as might be expected in view of the unstable factors involved. In Wisconsin, marked benefit was secured from irrigation in 1894 and 1895.[1] In Missouri, the yield was increased six times in dry seasons. The test of irrigation, however, is not how much it will benefit the crop in a single dry year, but whether it will pay over a series of years. In 1901 the New Jersey Experiment Station concluded: "Combining the results of four seasons, irrigation has given a small increase in early yield only.

[1] Rept. Wis. Exp. Sta., 1894, pp. 332–7.

PLATE VI. IRRIGATION. — *Top*, nursery piped for overhead sprinkling irrigation ; *center*, irrigation ridges, Pajaro Valley, California ; *bottom*, irrigation flume, Tropico, California.

The total yield of the irrigated plot was no greater than that of the unirrigated. The increase in early pickings was not sufficient to pay for the irrigation."[1]

It is doubtful whether irrigation in humid regions will pay under field conditions unless the water can be applied at little expense. In most cases it is more feasible to increase the water-holding capacity of the soil by adding humus and to prevent the loss of soil water by maintaining a protecting mulch of stirred soil or straw. When strawberries are grown under intensive market-garden culture, irrigation may be practicable, especially if in rotation with other crops that are benefited by irrigation. A number of strawberry nurserymen have installed irrigation plants, with profitable returns.

Special difficulties.

Irrigation in humid regions presents special difficulties. Chief of these is the necessity for good drainage. It is easy to water-log a soil by irrigation unless it is well drained naturally or is underlaid with tile drains. Another difficulty is the extreme care that is necessary to secure firm berries; over-irrigation gives soft berries. For this reason, some growers irrigate only during the first summer, so as to encourage the development of strong plants, and do not use water during the fruiting year. Irrigation is more likely to be practicable in home gardens and in market gardens near large cities than where the fruit is shipped a long distance. A serious difficulty, in many cases, is the cost of water. In arid regions irrigation usually is a community enterprise, thus reducing the cost to the individual. In humid regions it is, necessarily, a private enterprise.

[1] Rept. N. J. Exp. Sta., 1901, p. 234.

Furrow system.

Surface or gravity irrigation by means of furrows is the cheapest method when feasible. Surface irrigation requires that the land be brought to a uniform grade and all hollows filled. In arid regions the subsoil usually is like the surface soil and no harm is done by grading. In humid regions the subsoil usually is quite different from and frequently inferior to the surface soil. Grading may seriously injure the field, temporarily at least. Land with a uniform, gentle slope is essential for furrow irrigation in a humid region.

Overhead pipe, pressure or sprinkling system.

The overhead pipe system of irrigation finds favor among market-gardeners. The water is applied from pipes, under a pressure of fifteen to forty pounds. Usually it is pumped directly into the system, not to a reservoir. The mains are laid in the ground 300 to 400 feet apart. They should be smaller at the end of the line than at the beginning, so as to maintain a uniform pressure. Smaller laterals, 150 to 200 feet long, are run from these, spaced forty to fifty feet apart. The laterals are carried on posts seven to eight feet high, so as to permit horse tillage beneath (Plate VI).

The laterals may be level, but a slight fall is preferable. They are fitted with small brass nozzles, placed three to four feet apart in a straight line. These throw a spray twenty to thirty feet. The laterals are attached to the main with an adjustable union, which permits them to be rotated so as to direct the spray first on one side, then on the other, thus covering a strip forty to fifty feet wide. The turning can be done by hand, or with a hydraulic oscillator. This connection also permits the spray to be

thrown high or low, according to the direction and velocity of the wind and how far it should carry.

The water is turned on only between four P.M. and nine A.M., or on cloudy days; if applied while the sun is shining, much of it is lost by evaporation and the leaves and berries are scalded. From three to seven hours are needed for each sprinkling, so as to apply at least one-half inch of water, preferably more. When the water is turned on, the field appears to be covered with a heavy fog.

If a town water supply under pressure is not available, it is necessary to pump water from a stream, spring or well. A three and one-half horsepower engine is needed to pump water for a single acre, an eight horsepower for four acres and a twenty-five horsepower for twenty acres. The cost of installing equipment for overhead irrigation is $85 to $200 an acre (not including the pumping plant and the mains). After it is installed there is practically no expense except for pumping, and the equipment lasts many years.

For humid regions overhead irrigation has several distinct advantages over gravity irrigation. It permits the ground to be occupied completely with plants. This is the main reason why it is preferred by market-gardeners and truckers. Furthermore, it can be used on any type of land, whether level or sloping, and no preliminary grading is needed. It does not pack or puddle the soil. After once installed the upkeep is much cheaper than in surface irrigation and it is more convenient to operate. The overhead system is economical of water; gravity irrigation is quite wasteful of water. Some growers have found overhead sprinkling useful for warding off light frosts. On the other hand, the expense of installation is so heavy as to make this method impracticable except on land under intensive cultivation.

CHAPTER V

TRAINING THE PLANT

Fruit-growers do not agree on the best method of shaping the top of a fruit-tree, so as to space its bearing surface most effectively. There is even less unanimity on the training of the strawberry plant. The object in this case is to determine the most suitable distance between different plants, rather than to distribute different parts of the same plant; but the problem is essentially the same — to space the fruit-bearing surface so as to secure the largest return from the land occupied. The strawberry adapts itself to such diverse climates and cultural ideals that uniformity of practice in training cannot be expected.

METHODS OF TRAINING DEFINED

There has been lack of definiteness in referring to the different methods of training. Several have been known by more than one name.

Hill, or stool.

In hill training, the plants are not allowed to set any runners; these are cut or pulled off as they appear. Hill plants become very large and have many crowns. This is due to the branching of the main stem from adventitious buds; it is the common result of heavy pruning with nearly all kinds of plants. Sometimes two rows of hill

plants are set six to eighteen inches apart, with a wider interval for tillage between pairs of rows. This double row or twin row is used merely for convenience in tillage and is not distinct from hill training.

Hedge-row.

The plants are set eighteen inches to two feet apart in the row, the rows two and a half to three feet apart, if for horse tillage, and two feet apart for hand tillage. Two or more runners from each mother plant are aligned in the

Fig. 3. — Single hedge-row.

row; these are set by hand. Sometimes but one runner is set on each side of the mother plant and six to nine inches from it. A runner from this maiden plant may be set in the space between the mother plants. All runners thrown out subsequently by the mother plants and by these hand-set layers are removed. The result at the end of the season is a row of large plants, six to ten inches apart. This is a single hedge-row (Fig. 3). When another row is formed on one side of this, taking runners either from the mother plants or from the maiden plants or both, the result is a double hedge-row. This method is not used to any extent. When a row is formed on each side of the mother plants the result is a triple hedge-row (Fig. 4); some have called this the "double hedge-row" and others the "triple hill."

The triple hedge-row is formed by bedding four runners

from each mother plant, two in the row between the mother plants and one on each side of the mother plant and opposite to it. Then one runner is layered from each of these four in order to complete the outside rows. Occasionally

Fig. 4. — Triple hedge-row. (Sometimes called double hedge-row.)

it is made by bedding but two runners from each mother plant; these are set at an angle so as to make two outside rows. Again, if the mother plants have been set far apart and the variety has short-jointed runners, four runners may be bedded from every plant like an X, the mother plant being in the center. The distinguishing feature of

Fig. 5. — Spaced row.

this method is that there are one, two or three rows of aligned and spaced hand-set plants.

Spaced row.

This differs from the triple hedge-row chiefly in the matter of alignment (Fig. 5). No attempt is made to keep

the plants in line. Runners are layered all around the mother plants, and spaced approximately equidistant, so as to fully occupy the ground. If no runners are set from these maiden plants, the result is "cart wheel training," which was practiced by J. M. Smith of Green Bay, Wisconsin, forty years ago; the mother plant is the hub and the runners radiating from it are the spokes. More frequently two or three runners from each maiden plant are hand-set, until the entire space between the mother plants has been filled with layers about five or six inches apart; after this, all runners are removed. The result is a row twelve to fifteen inches wide, the plants not aligned but quite uniformly spaced. This is sometimes called a narrow matted row, but is quite distinct from that method.

Matted row.

This differs from the preceding method in that the runners are not bedded by hand; for the most part, they are allowed to form and take root at will and no attempt is made to regulate the distance between plants. The number of runners and the width of the row may be regulated by the use of runner cutters or tillage tools while they are forming; or the plants may be thinned and the rows narrowed after the runners have set. The most vital point in strawberry training — the distance between individual plants, is not regulated; the runners mat or root where they happen to strike. The matted row is "wide" or "narrow." These are relative terms; generally speaking, rows under fifteen inches wide are called narrow.

There are gradations between the spaced row and the matted row. Frequently the first runners may be set by hand but subsequent runners allowed to root at will, up

to a certain point. Usually, however, spacing in the matted row is secured not by bedding the runners as they appear but by thinning the plants in late summer or fall after they have rooted.

Broadcast, or matted bed.

This term is used to designate complete absence of runner restriction. In the wide matted row, it is customary to leave a narrow unoccupied strip between each pair of rows, to serve as a path for the pickers and to provide partial tillage. In broadcast training, the runners are allowed to cover the entire ground and are not thinned, so that they make a dense mat of plants over the entire surface. This method now is seldom used.

More strawberries now are grown in narrow matted rows than any other method of training, especially in Canada and northern and central United States. Florida, the southern part of the Gulf states and the Pacific coast are the strongholds of hill training; but even in these sections hedge-rows and spaced rows are gaining in favor. While each method has advantages for certain conditions, the steady drift away from unrestricted and unspaced runners is significant.

FACTORS THAT DETERMINE THE METHOD OF TRAINING

The best method of training is that which most perfectly fits the climate, soil, variety and method of culture.

Climate.

Where the ground freezes deeply and there are extremes of temperatures in rapid succession, especially in early spring, hill or hedge-row plants are more likely to suffer by

heaving than matted row or spaced row plants. Large plants with many crowns are not anchored as deeply and firmly in the soil as small plants. If fruited more than one season they tend to rise out of the ground, because new roots start higher on the stems; this favors injury from heaving. In a matted row, the roots permeate the entire surface soil and hold it so that there is less heaving. Plants in the matted row protect one another to some extent. The regions in which hill training is common have a mild climate and deep freezing is unknown. The more severe the climate the less advantageous it is to grow large, isolated plants. Plants in hills suffer more from frost than plants in matted rows, as the blossoms are not as well protected by the foliage. In a mild, humid climate which is conducive to a rank growth of weeds, even during the winter, as on the North Pacific coast, hill or hedge-row training is most practicable because it permits tillage close to every plant. Conversely, in the semi-arid sections of North Dakota, where there is no water for irrigation, hedge-row training is practiced so as to be able to till most of the ground. Hill plants suffer more from drought than hedge-row or spaced row plants. This is partly because they are rooted higher in the soil; but chiefly because a single hill plant, bearing a quart of berries, requires as much water as a dozen smaller plants occupying the same area, but cannot get it as readily since its roots are not so well distributed. Still another climatic influence is observed in Florida and the southern part of the Gulf states. There it is necessary to isolate each plant in order that the low winter sun may strike all around it, and color the berries, which ripen very slowly at that time of the year; in matted rows the fruit ripens very poorly and moulds.

Soil.

On rich, heavy soils plants are viney; on light soils of average fertility the same variety makes only a moderate number of runners. There is more necessity for restricting runners on clay soils than on sandy loams. The relation of richness of soil to method of training is considered on page 30.

Variety.

Hill or hedge-row training is most successful with varieties that normally make large, compact plants, set few runners and produce fruit of large size. Sharpless, Triomphe, Jessie, Marshall and Parker Earle are examples. In the Pacific Northwest, where hill training is preferred for Magoon and most other varieties, many find it best to grow Gandy, Glen Mary and Aroma in single hedge-rows, setting one runner from each plant. In 1900 and 1901 the New Jersey Experiment Station compared thirty-five varieties under hill and matted row training. Eleven gave heavier yields under hill training, the increase being 1000 to 6000 quarts an acre. Other varieties yielded about the same under both methods, while still others bore heavier in matted rows than hills, a few nearly twice as much.[1] This point should be considered in variety testing.

Varieties that make a superabundance of runners, as the Crescent, cannot be kept in hills to advantage; the expense of runner cutting is too heavy. Certain of the everbearing varieties, as Pan American and Autumn, bear fruit in the fall only on the mother plants and not on the runners of that season; these should be kept in hills. In everbearing varieties that have Louis Gautier blood in them, as Francis and Americus, the young runners begin

[1] Repts. N. J. Exp. Sta., 1900, pp. 234–7; 1901, p. 235.

to bear as soon as they are rooted; these may be grown to advantage in matted rows.

Method of culture.

If growing strawberries under intensive culture for a near market, spaced rows or hills may be more profitable than matted rows; when catering to the general market and producing fruit in large quantity, the reverse may be true. Hill and hedge-row training are preferred by market-gardeners who enrich the soil very liberally and cater to a special trade which demands fancy berries.

The labor required properly to care for the plants under the different methods of training also should be considered. One man may be able to care for five acres trained in narrow matted rows easier than one acre trained in hills. Three acres is about as much as one man can take care of properly in hills under intensive culture; this may represent a larger investment of time and money than twenty acres under average field culture. Each man has to decide what degree of intensive or extensive culture will be most practicable for him and then select a mode of training that will produce the grade of fruit that his market prefers.

SPECIFIC EXAMPLES OF THE SEVERAL METHODS

Hill training.

In the East, this method is commonly associated with the most intensive home garden or market-garden culture. On the high-priced market-garden land near Boston, hill training has been practiced for over a century. The plants are set in beds one foot apart each way, four rows to a bed, with a path two feet wide between beds. This

requires 35,000 plants to the acre, which is a large initial outlay. Heavy manuring and fertilizing are necessary and tillage is with the wheel hoe. The beds are fruited but one year, as a rule. Gross sales of $1000 an acre are not uncommon. This method is not practicable except when a good local market, where fancy berries command a price considerably above the average, is accessible.

Theoretically, it is possible to secure much larger yields to the acre from plants grown in hills than in matted rows; practically, the spaced row or hedge-row usually outyield hills. Strong hill plants set at this distance should produce a pint to a quart to the plant, giving a possible yield of 35,000 quarts an acre. It is seldom, however, that a yield of over 20,000 quarts an acre is reported. The berries from well-grown hill plants average considerably larger than those from plants trained in other ways.

In recent years a method sometimes called the "Kevitt system" has had much publicity. It has been described as follows[1]: "Mark out beds four feet apart; path between each bed one foot nine inches wide; set out plants in the four-foot beds one foot apart each way. This will give you five plants to each row. Keep young runners cut off as fast as they grow. Each season when plants are through bearing earth should be ridged around each plant as you would corn, taking it from the paths, thus giving each plant some new soil near the old crowns where the roots start from. Plants will continue to bear fruit year after year in the same bed without renewing; that is, the original plants may be retained. On my farm may be seen Glen Mary plants nine years old still yielding a full crop each season." Kevitt applies thirty tons of manure

[1] 1910 Catalog of T. C. Kevitt, Athenia, N. J.

PLATE VII. — A hill plant, showing its numerous crowns. These are branches of the main stem resulting from cutting off the runners. Hill plants require heavy fertilizing and, in the North, careful mulching. This method of training is more practicable in the South and on the Pacific coast than in the North.

to the acre and sets strong layer plants in August and early September. This is, of course, not a new "system," but merely a slight variation of the hill training practiced years ago by C. M. Hovey, John Knox, Peter Henderson and going back for several centuries. It requires a prodigious amount of labor and is a heavy expense. It is a special method for a special purpose. Most persons who try it fail because they begin with too large an area. An acre is enough to keep one man busy the first season.

Matted rows.

Broadcast training has practically disappeared from North America. The wide matted row, which often approaches broadcast training in effect, is used occasionally. The vicinity of Norfolk, Virginia, is now about the only important shipping district in which the runners are practically unrestricted. There are special reasons why this method has retained popularity there. The plants are commonly set in April between rows of a companion crop of potatoes, cabbages or other truck crop. This makes the rows of strawberries about six feet apart. The winters are very mild and weed growth, especially chickweed, is almost continuous; the growers assert that clean tillage with narrow matted rows would be too expensive. Again, there is much danger of late spring frosts; these make the investment so uncertain that the growers are convinced it will not pay to expend more in restricting the runners. Earliness is the chief factor in the profit of the Norfolk crop. The wide matted rows bear fruit several days earlier than narrow matted or spaced rows and the fruit is somewhat firmer, though smaller and of poorer color. Moreover, there is less need for mulching; the stand of plants is full and they are

usually accompanied by a thick growth of crab-grass and other weeds. The runners are allowed to spread at will, often matting into rows five feet wide, and practically covering the entire surface. The Norfolk method seems very crude, yet it is apparently well adapted for the conditions prevailing there. The aim of the trucker is to secure the largest total profit for the season from all crops in the rotation, rather than the largest profit possible from any one crop. It is likely, however, that a somewhat larger degree of runner restriction and weed control would be profitable. Save in the vicinity of Norfolk, most matted rows are narrow — under eighteen inches wide, and with a strip of tilled land one and a half to two and a half feet wide between rows.

Given equal care, strawberries in matted rows usually outyield hills. At the New York State Experiment Station, "The matted rows yielded the largest quantity of fruit in every instance." For many years the Pennsylvania Experiment Station recorded the average size of berries under hills, wide matted rows and narrow matted rows, finally concluding, "The narrow matted row produces the largest and most uniform grade of fruit." These results fairly represent general experience throughout the North. Immense yields frequently are secured from hills, but these are due more to heavy fertilizing and intensive culture than to the method of training. Other things being equal, each of the numerous crowns on a hill plant does not produce as much fruit as it could were it a separate plant, occupying a separate bit of soil. The narrow matted row and its companion method, the spaced row, are firmly established as the most popular North American methods of training when heavy yields of high-grade berries are sought.

Spaced row and hedge-row.

The effort to effect a compromise between hill and matted row training has resulted in hedge-row and spaced row training. There is little difference between the triple hedge-row and the narrow spaced row, except as regards alignment; the results are identical. A special advantage of the hedge-row is observed in harvesting the crop; most of the berries lie in windrows so that the pickers are not obliged to hunt for them and can pick more, and there is less danger of bruising the fruit. The hedge-row admits of tillage very close to the plant. Hedge-row training requires constant attention to the bedding and removing of runners; this makes it expensive. If the runners are allowed to mat before bedding the few that are to remain, it is difficult to get a satisfactory row. The single hedge-row is open to the objections that have been raised against hills as regards winter injury and drouth resistance. Hedge-row training is suitable for the more intensive types of field culture and the production of fancy berries.

The spaced row is more economical to form and to maintain than the hedge-row, and the yield is larger. One of the first to use the spaced row was J. M. Smith of Green Bay, Wisconsin, about 1875.

BEDDING THE RUNNERS

In hedge-row and spaced row training, the runners are set by hand. Even in matted rows often it is advisable to bed the first set of runners that are allowed to remain. The strawberry plant tends to throw out most of its runners from one side, in the same direction that it was attached to the mother plant. By bedding runners

around the plant a more uniform row is secured. Furthermore, the first runners root with greater difficulty than those that appear later; they are more likely to be blown about.

When to begin bedding.

Some growers remove only the first four or five runners, others keep them cut off until midsummer. This conserves the strength of the mother plant, upon which the runners would draw heavily for some time, if allowed to remain. Many varieties make weak runners early in the season and strong runners later. The longer it is possible to work close to the mother plant, without being obliged to narrow the cultivator on account of runners, the more thorough and economical is the tillage. Especially is this true in matted-row training; when runners begin to spread, weeds begin to flourish.

Late bedding, however, has several disadvantages. In the North, plants about one year old are thought to be more productive than younger plants. Many growers in the South are convinced that the opposite is true; they prefer late runners. There is more likely to be drouth in July and August than in June; late bedded runners may fail to make a good stand. Some varieties throw out few runners during the season if the early ones are allowed to root; if kept cut off until midsummer, runner production is aggravated. This may be a serious objection in matted row training.

The best practice depends on local climate and the variety. If the locality is visited more frequently with drouth in June than in August, late bedding may be more successful. The runners may be kept off strong-running varieties later than would be feasible with moderate plant-

makers. Some sorts, as the Clyde, make plants early in the season and few in late summer; others, as the Warfield, make plants quite uniformly throughout the season. Mother plants should not be allowed to support runners until well established. When early bedding is desired, prompt removal of the flower-stalks as soon as they appear will encourage early runner-making.

Methods of bedding.

In humid regions, runners root easily. It is possible to handle the cultivator so skillfully that it will cover the tips of runners lightly with soil. All that may be necessary is to place a small stone, clod, piece of sod or handful of soil on the runner cord, just back of the growing tip. If small roots have appeared, press the tips into the soil, and hold the runner cord in place with soil or gravel. In dry weather and in arid regions it is necessary to bed runners to be sure of a full stand. In the prairie regions, strong winds blow them about; it is essential to hold them firmly in place. Sometimes an inverted crotched stick is used for this purpose.

F. G. Tice, of New York, gives the following advice: "Bedding the runners is done astride the row, using a home-made tool. Train runners in front of the plant, as the bedder is working, to the left; train those behind the plant to the right. This prevents the bunching of runners and allows the extra plants to run out into the alleys, where they are cut off." The bedding tool is a piece of hoop iron fashioned like a wide putty knife. A slit is made in the ground, the tip is thrust into this and the soil pressed around it. Runners from weak mother plants should not be bedded; use runners from adjacent strong mother plants. The time required depends somewhat

on the variety; Crescent and Dunlap root readily; Marshall and Bubach do not. One man can bed 5000 to 10,000 tips a day.

Distance between bedded plants.

This is determined by the method of training, the variety, the strength of the soil and the distance between mother plants. Up to a certain point, yield as well as quality is increased by wider spacing; beyond this point the yield decreases, although the individual berries may be larger. The relation between the stand of plants in a matted row and the yield to the acre is shown in experiments reported by H. F. Hall, of New Hampshire:[1]

YIELD AS AFFECTED BY DISTANCE BETWEEN PLANTS

	No. I BERRIES	TOTAL YIELD
Sample 3 inches apart . .	3521 qts.	5667 qts.
Sample 6 inches apart . .	8028 qts.	9680 qts.
Sample 8 inches apart . .	6796 qts.	7836 qts.
Brandywine 3 inches apart	1609 qts.	2922 qts.
Brandywine 6 inches apart	4810 qts.	5753 qts.
Brandywine 8 inches apart	4963 qts.	5387 qts.
Glen Mary 3 inches apart	3458 qts.	5812 qts.
Glen Mary 6 inches apart	6615 qts.	7823 qts.
Glen Mary 8 inches apart	5182 qts.	6370 qts.

The point of diminishing returns may be four inches under one set of conditions and eight inches, or more, under another. In this case it was about six inches.

[1] Bul. 137, N. H. Exp. Sta. (1908), p. 161.

REMOVING SURPLUS RUNNERS

This is the most laborious task in strawberry-growing and the one most commonly neglected. There are two methods of handling surplus runners; to treat them as weed parasites and remove them as soon as they appear, or to let them root and then remove them in the autumn. The first method conserves the strength of the remaining plants, and is preferable except in matted row training.

Controlling the width of the matted row.

There are two distinct problems; to keep the plants in narrow rows, so that the inter-spaces may be tilled effectively; and to prevent the plants in the row from setting too close. These are conflicting purposes; the method that is most effective for restricting the width of the row — frequent use of the cultivator — throws the runners back upon the mother plants and results in crowding within the row. G. L. Perrine, of Illinois, advises: "Avoid the crowded matted row by spreading the row very rapidly. When the plants begin to form, instead of crowding them together with the cultivator, we allow the row to widen rapidly; then if it gets too wide, simply cut it down with the cultivator or disk." This method, however, precludes thorough tillage in a period when weeds grow rapidly and drouth is imminent.

If the runners are not bedded, the cultivator may be used to throw them around in a line with the row. The cultivator should be run the same way at each working so that there will be less danger of pulling up the partially-rooted runners. After the space between the mother plants is filled, the cultivator is run a little farther from the plant at each working.

After the matted row is wide enough the real fight begins — to keep it from spreading into the alleys and to prevent crowding within the row. Various types of tools are used to cut off alley plants. If the land is not stony, a rolling plow coulter, about ten inches in diameter, may be attached with clips to each side of the cultivator. Several patented runner-cutters are made; most of these are sharp, revolving disks. There is also a knife device which is attached to the frame of the cultivator. The runner cutter may be attached to a hand wheel hoe rather than to a cultivator. These tools do fairly good work but may cut off leaves, pull up the mother plants and occasionally cut off roots. A sharp hoe, and frequent recourse to hand pinching and cutting with shears or knife often are more satisfactory methods.

Spacing plants in the matted row.

While this struggle to limit the width of the row has been going on, an even more strenuous fight has been in progress within the row. The runners thrown back by the cultivator take root and produce more runners. The mother plants continue to make runners. If the variety is prolific of plants, they soon fill all the space. The plants compete with one another for light and food; many are starved and shaded to death. The advantage of a narrow row now becomes apparent; the larger the proportion of outside plants, adjacent to the tilled area, the higher the average of size and vigor. This observation, carried a step farther, leads to the spaced row.

Spacing of plants in the matted row is secured either by cutting off the surplus runners by hand as they appear, or by fall thinning. The first method is too tedious and expensive except for varieties which make few runners.

In most cases it is best to wait until fall to thin the rows. A toothed implement is dragged across the rows, not lengthways, to draw the weak runners into the alleys. This is done when the growing season is drawing to a close; in September or October, according to the locality. Runners formed after that time are winter-killed. Weak runners are uprooted and pulled off. An iron rake or five-tined potato digger are used. Fall thinning by hand costs eight to ten dollars an acre, which is less than the same results could have been secured for by cutting off the runners during the growing season. In large operations, a spike-toothed harrow or weeder is dragged over the bed each way. There are so many uprooted plants that the field may look ruined. Many of these are not pulled off, but dry out and winter-kill.

Another method is to cut out part of each row with a hoe or plow. A hoe with a short blade about three inches wide is drawn squarely across the row, cutting off all plants. Then a space of the same width is left, then another strip of plants is removed, and so on. In case of severe crowding the row may be thinned by checking with a light, one-horse turning plow or single shovel. Furrows are turned across the rows every three feet. The middle of each row is then split lengthways, which leaves the field in checks about three feet square. It is then harrowed both ways. By this time the field looks like a seed-bed, but the crop harvested the following spring may justify this heroic treatment. Part of the benefit is due to the control of winter weeds. Fall thinning with the plow is practiced most commonly in the South, especially in Missouri and Arkansas; thinning with the rake or harrow is more satisfactory in the North.

Fall thinning is gaining in favor. Few growers who have

a large acreage in the narrow matted row are able to keep all the superfluous runners cut off during the growing season, as this involves so much labor. Fall thinning is the next best plan, if done with judgment. In dry seasons, when the mother plants have set comparatively few runners, fall thinning may not be desirable. In wet seasons, when the runners are badly crowded, it may make a decided difference in the crop. The thinnings that are well rooted can be used for fall planting, or heeled in for spring planting.

Runner control in hills, hedge-rows and spaced rows.

In those methods of training which attempt to maintain a definite number of plants, equally spaced, the problem is simpler. After the permanent plants are bedded, it is necessary merely to cut off all other runners as they appear. This is easy to advise but quite laborious to practice. Most sorts throw out many runners throughout the season and require almost constant attention. When plants are fruited four or five years, which is quite common in hill training, there are fewer runners after the second season.

There can be no recourse to fall thinning in hill and hedge-row training. If surplus runners are suffered to remain, they defeat the chief object of these methods of training, which is to have but few plants and remove these from competition with others of their kind. When the spaced row is full, alley plants can be cut off with a roller cutter, and late-formed runners removed with an iron rake; but most of the surplus runners must be pulled by hand. In most of Canada and northern United States it is not necessary to remove runners formed after September first, as they are winter-killed.

If runners are cut before they have tipped, the formation

of fruiting crowns is encouraged. In an experiment by U. Dammer, six rows of Sharpless of fifty plants each were used; one row had all runners removed weekly; from the next row runners were removed every two weeks; from the last row every six weeks. Row one produced 916 berries, row six 482 berries. The experiment indicated that by removing the runners as soon as they appear, the number of fruit stalks is increased but the season of ripening is delayed somewhat.[1] This accords with general experience; matted rows are several days earlier than hills or hedge-rows of the same variety. If the runner is cut close, between the first joint and the parent plant, it is destroyed; if cut beyond the joint, a new plant may form at that point. One reason why rolling runner-cutters are not more effective is because they do not cut close enough.

Runners sometimes are removed most advantageously by pulling or pinching. The work should be done frequently, before the cords get tough. If several are jerked off together, the roots of the mother plant may be disturbed. Many prefer to use a knife or shears; a sharp hoe is serviceable also. Where the fruiting season is protracted, as in California, runners are pinched when picking or hoeing.

There are several special devices for cutting runners on hill plants; these can be used to some advantage on hedge-rows also. The circular dropper has been in use since 1869 and is still most popular, especially on the North Pacific coast (Plate IX). This is made of a piece of sheet-iron about twenty-eight inches long and six inches wide, with one end sharpened. The ends are riveted together, making a cylinder about nine inches in diameter. Cyl-

[1] Gard. Chron. 1899, pp. 217–18.

inders may be made in different sizes to fit plants of different ages; some are made fifteen inches in diameter. Two pieces of strip iron are attached to opposite sides of the cylinder and extend upward about six inches, joining in the center to a handle of wrought iron about three feet long, with a wooden cross piece at the top. The cutter is plunged down over the plant; a single stroke severs all runners if the cutting edge is kept sharp. Occasionally the dropper is made in a semicircle.

Other types of runner-cutters are used occasionally. A brush scythe, twelve to fourteen inches long and hanging straight, is used somewhat in the Puget Sound district. It clips off the outer leaves as well as the runners. There are several tools that have iron fingers that automatically gather up the runners and draw them under knives; these have not proved practical. C. S. Pratt of Reading, Massachusetts, uses two wheels with knife edges, spaced fourteen inches apart on an axle. The edges are drilled on so that they can be taken off and sharpened. This is pushed over the hill or hedge-row, and cuts off runners on two sides about seven inches from the center of the plant. Then it is used in the opposite direction and cuts the runners on the other two sides. It weighs sixty pounds, so that it cuts much better than the ordinary light roller cutter that is attached to a cultivator.

The mother plant produces more runners than any one of her progeny. It has been advocated, therefore, that in matted row or spaced row training, the mother plants be dug out as soon as enough runners are established, so as to avoid the necessity of removing the runners made by them during the remainder of the season. If the season is wet and the layers quickly become independent of the parent plant, this might be done to advantage; but if the

season is dry, it may seriously weaken the layers, which are partly supported by the mother plant long after they are apparently well rooted.

Summer pruning.

Runner control has reference to the distance between individual plants. This is spacing rather than pruning, although the constant removal of runners from plants is, in effect, severe pruning. Beyond this, pruning of the individual plant is rarely necessary, except mowing the old leaves after the crop is harvested, preparatory to a renewal of the bed. Yet there are occasions when summer pruning is advisable, chiefly in regions having a mild climate and where the fruiting season is prolonged. The method practiced by the strawberry-growers of Mahableshvar, India, has been described by W. Burns.[1] "The cultivators have a curious and interesting practice of reducing the vegetative growth of the plants in order to promote flowering. This is done by taking off leaves and their axillary undeveloped shoots twice a month." A similar method is followed to some extent in southern California. At intervals of a month or more the plants are "cleaned up," being denuded of runners, and partially defoliated. The check caused by this summer pruning, and by the temporary discontinuance of irrigation, gives the plants a brief resting period, after which they again burst into blossom.

In the coast region of Oregon, Washington and British Columbia the mild climate and abundant rainfall are conducive to a very luxuriant growth, and some growers remove part of the leaves with a scythe in order to check growth. About 1860 summer pruning was commonly

[1] Agr. Jour. of India, Vol. IX, Pt. III (July, 1914).

practiced in the East on hill plants grown under high culture. It was claimed that this gave larger berries and that the fruit was sweeter, because it had more sun. With the advent of the matted row, interest in summer pruning declined. Leaf pruning is still practiced somewhat in Florida in order to expose the fruit to the low winter sun. Summer pruning of the strawberry is a special practice; in most cases all the leaves should be preserved.

CHAPTER VI

MULCHING

Strawberries are mulched primarily for two purposes, — to protect the plants from winter injury and to keep the fruit clean. In the North the same mulch is commonly used for both purposes; in the South a mulch is used for protecting the fruit only. These two objects are quite distinct, and different methods may be necessary to accomplish them. Mulching for the conservation of soil water has been discussed in Chapter IV.

The practice of mulching strawberries is nearly as old as the garden culture of this fruit. Some are of the opinion that the name of the fruit is derived from the ancient practice of laying straw under the ripening berries. But little attention was given to mulching in North America until after 1870. Many of the early cultivators followed the English practice of growing strawberries in hills, mulching them heavily with "long manure"; but most growers did not mulch at all. The Wilson succeeded without mulching, since it was grown in thick, matted rows and the beds frequently were kept for ten or more years without renewing. About 1865 John Knox, of Pittsburg, demonstrated the value of mulching hill plants of the Jucunda, which led to a more general adoption of the practice. Since 1870 mulching has steadily grown in favor.

ADVANTAGES AND DISADVANTAGES OF THE WINTER MULCH

Most of the mulching in North America is to secure both winter protection and clean fruit. The acreage of strawberries in the South that is mulched merely to keep the berries clean is small compared with that which is mulched for both purposes. Wherever the temperature drops to zero or below and the ground freezes to a depth of two inches or more, a winter mulch is likely to be profitable, especially on heavy soils. It is commonly used in all of Canada, except the Coast region of British Columbia; and in the United States as far south as Virginia, Tennessee and Missouri, also throughout the Rocky Mountain states. There is very little mulching in the Pacific coast states. In Maryland, which is near the southern limit of profitable winter mulching, the gain in yield from mulching was 475 quarts an acre, as an average of four seasons.[1] South of the latitude of Washington, D.C., it is doubtful whether a winter mulch is desirable, except in the mountains, as it harbors crickets and other fruit-eating insects, and the plants are likely to be bleached in warm weather.

A winter mulch may be beneficial in four ways. It may prevent the plants from heaving, protect them from extreme low temperature or drying out, conserve soil moisture and smother weeds. It may be used also to protect them from frost during the blossoming season; this is discussed on page 281.

Prevents heaving.

In most cases, winter injury of unmulched plants is caused by alternate freezing and thawing, rather than

[1] Bul. 160, Md. Exp. Sta. (1911), pp. 198–9.

by actual low temperature. Both soil and plants are expanded and forced upward, since water expands in freezing. When the field thaws the soil settles back into place, but the plants do not; their roots are torn loose, and they may be left upon the surface or with a very insecure hold on the soil. If they are not killed outright, the first severe drought finishes them. On clay soils, unmulched plants have been lifted six to eight inches during a single winter. Heaving is most serious upon heavy soils, especially if they are flat and poorly drained; sandy soils and well drained slopes heave very little. The more level and clayey the land, the greater the danger from heaving.

A mulch prevents heaving by preserving more equable conditions of soil temperature, and by preventing rapid thawing. Frozen plants that are thawed slowly, in the shade, are less likely to be injured than those that are thawed quickly, in the sun. The object of the mulch is not to keep the plants from freezing at all, but to prevent them from being affected by the frequent changes of temperature. In the North, snow is nature's mulch; if the ground is covered continuously with snow until spring there is no heaving. The necessity for mulching increases as the permanence of the snow blanket lessens.

Prevents freezing.

In the prairies of South Dakota, North Dakota, Minnesota and Manitoba, where the winters are very cold and dry, with little snow, a winter mulch is necessary to prevent the plants from being injured by low temperature. Even a dormant plant transpires a small amount of moisture every day during the winter. If the tissue of the plant

is desiccated, or dry, it is likely to be winter-injured; hence, some growers, especially in the Rocky Mountain states, saturate the soil with water late in the fall, after growth has ceased. A heavy mulch prevents transpiration from the leaves to a large extent. It may be as cold beneath the mulch as above, but the temperature is more equable and the loss of the moisture small. If the winter mulch is left on in the spring, it conserves soil moisture nearly or quite as well as tillage. If thick enough, it smothers various winter weeds. These matters are considered in the chapter on Tillage.

Retards the ripening season.

The berries on unmulched plants ripen several days earlier, often more than a week, than mulched plants. This is a decided advantage in the Norfolk region, and the South generally. It may be a disadvantage in those sections of the North that suffer from late spring frosts. Mulched plants are late because the mulch keeps them at a lower temperature, since all parts are covered. If a straw mulch is used, it may be due, in part, to the light color of the straw. When only a light mulch is used, the weeds are likely to push through it in the spring and give more trouble than if the rows had been kept tilled. In those parts of the North where it is necessary to use six inches or more of mulch, there is danger that some of the plants will be smothered.

Increases danger from frost.

If a heavy winter mulch is left around the plants during the blossoming season, it may increase the danger of injury from frost to a slight extent. W. R. Lazenby of Ohio has reported the comparative readings of thermom-

eters placed in a strawberry field, part of which was mulched and part unmulched. The temperature was found to be from one-half to three and one-half degrees lower over the straw than over bare ground; the readings were taken several times before sunrise. He concluded: "In some instances there appears to be sufficient difference in temperature to cause a frost on straw, while the unmulched portion might escape." Many of the common mulching materials are full of weed seeds; this is one of the most serious objections to the practice. The chief disadvantage of the winter mulch, however, is the expense, amounting to five to fifty dollars an acre, according to conditions. More growers are mulching now than ever before, which indicates that the advantages usually outweigh the disadvantages.

MULCH MATERIALS

The choice of mulch material is governed fully as much by availability and cost as by adaptation for the purpose. If wheat straw costs eight dollars a ton, the grower will endeavor to find a cheaper substitute. Any coarse vegetable material that will not pack so tightly over the plants as to smother them may be used.

Manure.

In early years, the winter mulch was commonly of strawy horse manure. Manure is so likely to be full of the seeds of timothy, clover and various weeds that it is rarely used now, except in the home garden or in small fields under intensive culture. The weed difficulty may be overcome, in part, by securing the manure in early summer and turning it over several times before fall.

Only strawy manure should be used; a heavy coat of fine manure upon the plants might smother them. Work the fine part of the manure around the plants and between the rows and use the strawy portion, or corn stalks, directly over the plants.

Straw.

Straw is used for a mulch more than any other material. Wheat straw is preferable to oat or barley straw, as it usually is threshed cleaner, is freer from weed seeds and does not pack down so tightly. Rye straw is least valuable; it is too long and there is likely to be considerable difficulty from re-seeding. Buckwheat straw is excellent. All kinds of straw contain cheat, wild barley and other seeds, which become serious weeds in the strawberry field. Moreover, the scattering kernels of grain in the chaff and screenings are likely to grow and cause trouble in the spring. Shake out the straw before using it, or fork it over a coarse screen to sift out the seeds. Some growers prefer old straw for this reason, especially if it has been tramped over by stock and made finer. Two to eight tons an acre are used, according to the locality. Under average conditions in the North two acres of wheat will supply straw for one acre of strawberries.

Corn fodder.

Corn stalks make an excellent mulch in Minnesota. One bundle is laid on each side of the row and a third on top of the row. In regions that have a more moderate winter, corn stalks are likely to smother the plants unless they are cut or shredded. Shredded corn fodder is a good mulch, but expensive. It is free from weeds, except of morning glory. It is commonly estimated that

ten acres of corn fodder will mulch two acres of strawberries in the latitude of Ohio.

Growing a mulch crop.

When it is necessary to grow a crop especially for mulching, the choice usually is sorghum, cowpeas or soybeans. Sorghum is sown thickly so late in summer that it will not head before frost; in case it shows a disposition to head it should be cut. If sorghum hay is stored under cover it can be used for two seasons. In the South, sugar-cane is preferred to sorghum; it is seeded at the rate of two and a half bushels to the acre.

Corn, sowed broadcast or drilled very thickly about midsummer, so that it makes very small stalks like sorghum, is about as serviceable. The usual rate of seeding is eight to ten pecks an acre. The corn can be drilled in where the old strawberry bed has been plowed under. If it stands straight, it can be cut and tied into bundles with a wheat binder. These bundles are laid on the row of strawberry plants lengthways, touching each other; then the strings are cut and the mulch spread over the row. If, however, the corn is lodged, it must be cut with a mowing machine and handled like hay. In Michigan, an acre of corn grown in this way will cover two to four acres of strawberries, according to the method of training.

Japanese millet is used somewhat in the North, since it can be seeded late, after a crop of potatoes or sweet corn, or upon an old strawberry bed. In the irrigated regions of the Rocky Mountain states, an alfalfa mulch is preferred; it is comparatively cheap and contains no weed seeds. When it is removed in the spring, enough leaves remain to keep the berries clean. In the Pacific

Northwest, clover hay is used occasionally, especially the last fruiting year of the field. Timothy hay is objectionable, as it is full of weed seeds, and timothy itself is a weed in the strawberry field.

Other kinds of farm herbage are used occasionally, such as bean pods, bean vines, hop vines, potato vines, sorghum begasse and pomace. Flax straw is excellent; it lies close to the plants, but does not smother them. When removed in the spring, the bolls and chaff cover the ground and protect the fruit. Tobacco stems are of doubtful value, although they promote the growth of the plants. In the Norfolk district strawberries frequently are planted between rows of early cabbage, which are followed by snap beans or peas; the vines of these crops are left on the ground to assist the crab-grass in mulching the strawberries.

Mulches of wild herbage.

Many kinds of wild herbage may be used to advantage. Marsh hay, whether salt or fresh, is excellent; also prairie hay in the Mississippi Valley, and crab-grass, or wire-grass hay in the South. These wild hays usually are quite free from weed seeds. The small amount of salt in salt marsh hay does not injure the strawberry plants. In northern Vermont and on the Pacific coast where ferns and brakes grow luxuriantly, these are cut for a mulch. The leaves of various deciduous trees are used on small plantations in the North. Pine leaves or pine "straw" is the standard mulching material of the South, especially for keeping the berries clean. A leaf mulch should be light, rarely over two inches deep; if heavier, the plants may be smothered.

Wood moss is used sometimes, especially in Maine.

PLATE VIII. MULCHING. — *Above*, parting a heavy winter mulch from over the rows, Michigan; *below*, hill plants of Magoon, Vashon, Washington.

It must be put on very late in the fall and taken off early in the spring, or it will smother the plants. Seaweed is satisfactory for a winter mulch if most of it is ribbon weed, eel-grass or other coarse weeds; if it is mostly Irish moss or other fine weeds, it may smother the plants. If the spring is wet, a seaweed mulch favors rotting of the fruit. In Nova Scotia a mulch of rushes has been found satisfactory.

Several kinds of woody material are used successfully under certain conditions. In those parts of Canada and northern United States where the ground is covered with snow most of the winter, strawberries may be mulched with boughs or brush to keep the snow from blowing away. Evergreen trees, eight to twelve feet high, are used, preferably of fir; the branches are trimmed from one side so that the boughs will lie where placed. Some Manitoba growers prefer deciduous brush cut in summer so that the leaves adhere through the winter. Brush and boughs merely hold the snow, and do not make a mulch that protects the fruit; hence it is better to apply a light straw mulch first, with brush on top.

Miscellaneous mulching materials.

Planing mill shavings have given fair results, but sawdust is objectionable. If applied heavily enough to protect from winter injury, it lies so closely that it keeps the ground cold and smothers the plants. Moreover, the fine dust is spattered upon the berries. Pine sawdust is not as injurious as oak sawdust. Spent tan-bark, which was used extensively about 1850, was found undesirable. If used, it should leach for a year. Swamp muck has been used successfully when herbage material was scarce. In the North, plants grown in hills or hedge-rows have

been protected with an earth mulch; Patrick Barry suggested this in 1850. About one inch of soil is plowed over the plants in November; the following spring it is scraped off with a hoe. This method cannot be used except where there is not likely to be any growing weather during the winter. Where strong winds prevail during the winter, light mulching material, especially leaves, is liable to be blown away. This is one of the difficulties in the North Central prairies. Brush, corn stalks, a thin covering of manure, or a wire stretched tightly over the row, are used to hold the mulch in place.

GROWING A MULCH IN THE STRAWBERRY FIELD

Usually, the mulch crop is secured from outside the strawberry field. About 1870, when clean tillage between rows had become quite general, the idea was conceived of utilizing the tilled middles for growing a mulch of the small grains. More recently a number of northern growers have laid by their hedge-row plants in barley, seeded about September first at the rate of two bushels to the acre, and worked in with a twelve-toothed cultivator. The barley should grow one and a half to two feet high before it is killed by frost; this mulch is supplemented by a light covering of straw. Buckwheat, Kaffir corn and millet are used also for this purpose.

The main objection to growing a mulch crop in the strawberry field is that it exhausts the soil of moisture at the time when the plants are growing most rapidly and need it most. In Missouri and other sections having a mild winter, some years the mulch crop is killed by frost before it has made enough growth to afford protection; other years it lives over the winter and starts to

grow again in the spring, becoming weeds. This method is not advisable, except in the North, and then only with hill or hedge-row plants set on strong land and well tilled through the early part of the season, so that the crowns are strong. Even under these conditions it is risky; if the fall is dry, the plants may be seriously injured.

Crab-grass mulch in the South.

The counterpart of the foregoing method in the South is the weed or crab-grass mulch. In Delaware, eastern Maryland, eastern Virginia, and southward, and in southern Illinois, southern Indiana, and southward, a weed mulch is used frequently. The South is abundantly supplied with a weed that is peculiarly fitted for this service. If tillage is stopped in midsummer, the strawberry field quickly becomes a mat of crab-grass. This is allowed to grow at will; big weeds are chopped out by hand. Crab-grass is shallow-rooted; if the season has normal rainfall, it will not interfere materially with the growth of the strawberry plants. The first heavy frost kills it, leaving a thin covering of herbage upon the ground. Usually, this is enough to protect the plants from winter injury and heaving, which are not serious in the South, and to protect the berries from sand, but it is not heavy enough to be of much value for conserving soil moisture in the spring. It helps to crowd out chickweed and other winter weeds. Fields handled in this way ripen berries several days earlier than fields that are unmulched, or are mulched with straw; hence the method is valued in those parts of the South where early ripening is of prime importance. In the Norfolk district the growth of crab-grass is often so heavy that it is mowed in the fall and part of it raked off for hay, but this

practice is discouraged, as it is likely to make the berries sandy.

The chief advantages of the crab-grass mulch are that it is cheap and that it promotes early ripening. On the other hand, it is dangerous. If tillage is stopped too soon, the grass may smother the strawberry plants; if too late, there will not be enough grass to make an effective mulch. In wet seasons the plan works quite well; in dry seasons there is not enough moisture for both strawberries and grass, and the result is a light crop the following spring. The land is kept filled with weed seeds, which plague the grower the next year. The Maryland Experiment Station has compared a plot which received no late summer cultivation and hence was filled with crab-grass, with a plot cultivated until late fall and then mulched with wheat straw; also with a check plot which was cultivated until late fall, but not mulched.[1] The berries on the crab-grass plot ripened a week earlier than on either of the other plots, but yielded 708 quarts less an acre than the check plot and 3713 quarts an acre less than the plot mulched with wheat straw. It is probable that on the lighter soils of the South, when extreme earliness is desired, a crab-grass mulch will continue to find favor; but the drift is constantly away from such unpredictable methods towards cleaner culture and the greater certainty of a hand-placed mulch.

USE OF THE WINTER MULCH

For many years northern growers waited until the ground was frozen hard enough to hold up a wagon before spreading the winter mulch. This is not advisable, since

[1] Bul. 124, Md. Exp. Sta. (1907).

alternate freezing and thawing in the fall, before the ground is frozen hard, frequently injures the plants. On the other hand, if a heavy mulch is applied before the ground is frozen, the plants are likely to be smothered. Furthermore, there may be warm weather late in the fall which starts the plants into growth; then they turn yellow and are easily winter-killed. If the mulch is to be heavy, it is best to apply not over two inches in the fall and the remainder after the ground is frozen. A manure spreader, with a large straw rack attached, may be used to put on a thin fall mulch, which will cover the crowns, but leave the foliage exposed.

Where snow clings to the land all winter the mulch is spread as soon as there is enough snow for sleighing. This retards the season of blossoming and lessens the danger from spring frosts. In northern Wisconsin and parts of Canada, some growers prefer to wait until late winter, just before the snow melts. In the prairie regions, which are subject to high winds, it is advisable to mulch immediately before a rain or snow, so that the material will mat together and not be blown away. If using seedy straw, the later it is applied, the less the chance that the grains will sprout. Mulching is slow and often disagreeable work; if there is much to do, commence early.

How much to use.

Local climate, the variety, method of training and soil determine the thickness of the winter mulch. In Kentucky, two tons to the acre, or even less, may be sufficient; but in some parts of the Northwest eight to twelve inches of settled straw are considered none too much. "In this region," says N. E. Hansen, of South Dakota, "it has been a constant fight with nature to mulch heavily

enough to protect from winter-killing and yet light enough to avoid smothering the plants." In most parts of the North, however, a mulch three to four inches deep, after settling, is sufficient. It should be somewhat deeper between the rows than over the plants. On the upper peninsula of Michigan, most growers do not mulch at all, as snow covers the ground continuously throughout the winter. On the Coastal Plain of British Columbia, Washington and Oregon, the winters are so mild and wet that a mulch would rot the foliage. In the South, wherever the ground freezes to a depth of one or two inches a big handful of pine straw thrown over each plant furnishes sufficient protection; it is not necessary to cover the entire surface.

Tender, shallow-rooting varieties, like the Jucunda, require more mulch than hardy sorts, like the Dunlap. Plants grown in hills or hedge-rows require more than plants in matted rows. The farther apart the plants are the more mulch they require; when they are close together, as in a matted row, the tops protect each other and the roots interlace and hold the soil, and prevent it from heaving. In matted rows, the older the bed, the less mulch it needs; under hill training the reverse is true. In the North, hill plants, grown under intensive culture, require special care in mulching. The luxuriant foliage is likely to damp off if mulched heavily; the plants will heave if mulched too lightly. The material should be applied gradually. In the fall, fine manure, followed by dry leaves or short straw, is placed around each plant — not over it — by hand. Later, when the ground is frozen slightly, the plants are covered lightly with long straw, and more is added after the winter is well advanced. In the spring the mulch is removed with equal caution.

On sandy soils, mulching for winter protection may not be necessary, even in the North, except for hill plants; the lighter the soil, the lighter the mulch. The amount used will depend, also, on whether it is to be kept around the plants the following spring for moisture conservation. If making a specialty of late berries, mulch heavily; the heavier the mulch, the longer is season of blooming and ripening retarded. In 1898, S. R. Devine, of Sullivan County, New York, covered a field thirty inches deep with ice, with ten inches of straw above it. The berries ripened through July and August, and sold for fifty cents a quart, but the venture was not profitable. Now that we have dependable everbearing varieties, such extreme measures are unnecessary.

When to remove the mulch.

In most cases, the mulch is left around the plants to keep the berries clean. The advantages and disadvantages of removing the winter mulch in spring to permit tillage, are considered on pages 74–75. The mulch should not be removed until settled spring weather is assured. Do not be deceived by a day or two of prematurely warm weather; "maple sugar weather" is very trying to uncovered plants. Unless earliness is essential, the later the mulch is left on without injury to the plants, the better. The plants should be examined frequently; if they show signs of bleaching, they should be uncovered, regardless of the calendar. If the mulch is kept on late, not only does it retard the blossoming season, but also it smothers early weeds. It may pay to go over the field the first warm days and merely loosen the mulch over the rows with a fork, to prevent bleaching.

If the mulch is but two inches deep, or less, it is not

necessary to remove it from over the plants in the spring; they will push through. A heavy mulch must be parted over the rows by hand and pushed into the middles. In case the field is to have spring cultivation, the mulch can be shifted from row to row, as detailed on page 75; or it can be removed entirely with the horse rake or weeder. The weeder is less likely to pull up plants. Straw that has been used but one year may be stacked for use another season.

THE FRUITING MULCH

The foregoing paragraphs refer to a mulch that is applied primarily to prevent winter injury and, incidentally, to keep the fruit clean. Throughout the South and on the Pacific coast mulching for winter protection is not necessary, but mulching for fruit protection may be advantageous. Dirty fruit looks unattractive and sells poorly; it commands several cents less a quart than bright, clean berries. Dirty strawberries may be washed, but this hurts their appearance and shipping quality. The expense of mulching is slight compared with the added selling value of the fruit.

Whether or not to apply a fruiting mulch depends on the soil, climate, variety and method of training. More dirt is spattered upon berries by splashing showers than from direct contact with the ground. Where rains are infrequent during the fruiting season, as on the North Pacific coast, there is less need of mulching. The more sandy the soil, the less likely is it to be splashed upon the berries. The surface of some of the best strawberry soils in the Ozark district is almost entirely covered with small stones, which make an excellent mulch for conserving

PLATE IX. — *Top left*, circular dropper, used to cut runners from hill plants; *top right*, foot power stapling machine; *bottom*, fruiting mulch between rows of hill plants on drainage ridges, Florida.

soil moisture and keeping the berries clean. Varieties with long, stiff fruit stalks, like the Clark, keep most of the berries out of the dirt. When the plants stand rather closely together in matted rows, they hold up one another, and there is less need of a mulch than with hill and hedge-row plants. A fruiting mulch is more likely to pay with late sorts than with early varieties; even a light mulch retards ripening somewhat. Further advantages of the fruiting mulch that should not be overlooked are that it provides a clean, dry place for the pickers, and, to some extent, smothers weeds.

Materials used.

Any of the materials used for the winter mulch may be used in the spring also, provided they are short and fine enough to be worked around and under the plants easily. Throughout the South, pine needles, also called "pine straw," "tags" or "shatters," are used almost exclusively when available. This material is cheap, easy to apply, keeps the fruit clean and does not blow away readily, but is not a valuable source of humus. Where long-leaf pines are abundant, the straw is commonly gathered with a horse rake and is baled and shipped by the carload; it costs ten to twelve dollars a ton. In 1913 the Farmers' Association of Independence, Louisiana, secured 7000 acres of pine straw land in order to supply its members with mulching material at a low price. After the crop is harvested the pine straw is stacked for use another season, or is composted. It is commonly applied when the plants begin to bloom, occasionally earlier. If applied too early, it keeps the ground cold and makes the crop later. It is spread directly on the plants, which push through with little, if any, assistance. The amount

used depends on whether the mulch is expected to conserve soil moisture as well as to keep the fruit clean. If so, the straw should be about two inches deep after settling, and spread over the entire surface. If used only for protecting the fruit of hill plants, a few handfuls of straw may be placed over and around each plant. The pine straw mulch is used to advantage also for protecting the blossoms from frost (page 282). One objection to this material is that it harbors crickets and other insects which eat the fruit. Its dark color is a disadvantage; this absorbs heat, which is reflected upon the pickers; and the sharp needles warp up and prick their knees.

Cotton seed hulls and rice chaff are used to some extent in the South, especially hulls. Only enough hulls are used to hide the soil under the plants and for four or five inches on each side. Usually this takes three to five tons an acre; since hulls cost four to five dollars a ton, this is an expensive mulch, but the decaying hulls add to the soil a small amount of potash. Where wire-grass hay is abundant, it can be used to advantage for the fruiting mulch; it is free from weed seeds, soft and durable. About one ton to the acre is sufficient. In some parts of the South, especially in Florida, crickets and other fruit-eating insects are so serious in mulched fields that mulching is impracticable.

At the Arkansas Experiment Station the yield was increased one-third by spring mulching. One or two tons of straw or prairie hay are sufficient. A manure spreader is used to apply this light mulch. A wide frame is attached to the box of the spreader, and a man stays on top of the load to keep the straw packed down so that it will feed. Two rows are covered at a round more evenly and with less material than is possible with hand spread-

ing. The mulch should be applied several weeks before the blossoming season so that it will settle around the plants. There is very little mulching on the Pacific coast, except in home gardens and in the foothills. The large hill plants of eastern British Columbia sometimes are mulched with short straw worked under the plants, where it will not interfere with tillage. This is placed around them by hand when the earliest berries are as big as peas. Two tons of cut straw to the acre are sufficient. Where irrigation is practiced, a mulch is a decided inconvenience and is seldom used.

CHAPTER VII

POLLINATION

THE essential organs of the strawberry blossom are shown in Plate X. If any one of the numerous pistils is not impregnated, no seed will develop at the base of that pistil; and if no seed, then none of the pulp near it. If practically all the pistils are fertilized and the seeds develop, the berry will be large and shapely. If only a part of the seeds develop, through lack of pollen, unfavorable weather, insect attack or other cause, the berry will be small and misshapen. The fruit of the strawberry is not a "berry" in the botanical sense, like the huckleberry or gooseberry, but is an enlarged receptacle.

TYPES OF BLOSSOMS

The early botanists invariably described the strawberry as bisexual, although many of the wild plants were not so. Under the stimulus of cultivation and hybridization, the strawberry now shows great diversity in the sexual arrangement of the blossoms. C. W. Richardson, an English plant-breeder, enumerates these as follows:[1]

"1. Females with the male organs undeveloped.

"2. Females with most of the female organs atrophied, or hypertrophied and inefficient, no male organs being developed.

[1] Jour. Genetics, 3 (1914), p. 175.

"3. True hermaphrodites, with both male and female organs developed.

"4. Males with the female organs undeveloped.

"5. Males with the female organs only developed in a few flowers, generally the first flowers produced in each truss.

"6. Flowers with neither male or female organs developed, or with the female organs hypertrophied."

All of these types are found in North American varieties. Occasionally a single plant bears distinct pistillate blossoms, distinct staminate blossoms, and all gradations between, sometimes on the same truss. Practically all of the cultivated varieties of to-day, however, belong to classes one and three; the blossoms are either female, with the male organs not fully developed, or they are hermaphrodite, with both male and female organs fully developed. The other types of blossoms appear only occasionally, as a result of unusual conditions in food supply, temperature, or other factors in the environment. Plants with true male blossoms, and the female organs wholly abortive, were quite common before 1880. These male plants were absolutely barren and were useful only for pollinating female plants. Male plants still are found in the Hautbois and, to a slight extent, in other species. William P. Brooks has reported them in Japan among the native *Fragaria vesca*. In England all varieties, with the exception of the Hautbois, are hermaphrodite. For practical purposes, all North American varieties are either female or hermaphrodite.

Terms used in describing sex.

There has been much confusion in the terms used to designate sex in strawberries. Hermaphrodite varieties have been called "bisexual," "staminate," "perfect"

and "male." Female varieties have been called "pistillate" or "imperfect." Since true male plants are not grown now, there is no need of preserving that term and no danger of confusing male and hermaphrodite varieties, as there was once. In 1844, G. W. Huntsman proposed the terms "pistillate" and "staminate" for female and hermaphrodite varieties, respectively. These terms have been used more than others and are as satisfactory as any; it would be well if other terms were discarded. The classification of varieties as to sex cannot be exact in the botanical sense. The same variety may differ widely in sex, especially in pollen production, varying with soil, climate and culture. "Hermaphrodite" and "bisexual" are correct terms, botanically, but clumsy. "Perfect" and "imperfect" convey no meaning to the uninitiated. "Staminate" and "pistillate" direct attention to the essential organs and are more easily understood by practical growers. As these terms are now used, a staminate variety is one that has a sufficient number of well-developed stamens to be able to pollinate itself; a pistillate variety is one that does not produce sufficient pollen to pollinate itself, although it may have stamens and produce a little pollen. The classification is arbitrary and horticultural, not exact and taxonomic.

ARE PISTILLATE VARIETIES MORE PRODUCTIVE THAN STAMINATE SORTS?

The facts concerning the separation of sexes in the strawberry blossom, and the advantage of planting pollen-bearing plants with pistillate sorts, first were brought prominently to the attention of North American cultivators about 1845, by Nicholas Longworth of Cincinnati,

Ohio. This interesting chapter in strawberry history is given elsewhere.[1]

The theory of a division of labor in the blossom.

Although Longworth's theory that no hermaphrodite variety could be valuable perished with the introduction of the Longworth and the Wilson, many growers continued to believe, and some still affirm, that pistillate sorts, when properly fertilized, are more productive than staminate. The main argument in support of this contention is that there is "a division of labor" in the strawberry blossom. This idea was advanced in Longworth's day in an attempt to explain the fact that the pistillate varieties of that time were more productive than the staminate. It was argued that the production of pollen is an exhausting process; hence, plants that do not produce pollen are bound to be more productive, if properly pollinated from other plants, than those which develop both pollen and pistils. The fact that a certain number of pistillate varieties are more productive than an equal number of staminate varieties is not proof of this contention. Between 1860 and 1880 the Wilson, a staminate variety, was the most productive sort grown. During this period, A. S. Fuller and other authorities advised against planting pistillate varieties and recommended that none but staminate sorts be introduced thereafter, because of the many mistakes made by growers in planting pistillate sorts without providing a pollinizer.

Relative productiveness.

About 1878 the Wilson began to "run out," and there was a decided reaction in favor of pistillate sorts. This

[1] "The Strawberry in North America," Chapter III.

was due, in part, to the remarkable productiveness of the Crescent, a pistillate variety, which grasped the leadership relinquished by the Wilson. Between 1880 and 1900, a large number of growers, having such heavy yielding pistillates as Warfield, Bubach, Haverland and Greenville before them, believed that pistillate sorts are, and must be, more productive than staminate. In 1890 W. J. Green sent a list of leading varieties of both sexes to prominent strawberry-growers, requesting that the productiveness of each variety be marked on a scale of 10. The summary of the replies gave an average of 5.8 for the staminate, and 8 for the pistillate.[1] In 1912 the Ohio Experiment Station reported:[2] "The average yield from each eighteen-foot row of perfect varieties (139 varieties) was 5.47 quarts, and from each row of the same length of imperfect varieties (66 varieties) was 7.19 quarts. There are some high-yielding perfect flowered varieties, and some among the imperfect that give low yields; but it is generally recognized as a fact that the former, as a class, are less prolific than the latter."

Probably this conclusion is correct, as applied to all varieties; but when applied to individual varieties it is without weight. Outside of experiment stations, few persons grow more than five or six varieties. Since a considerable number of staminate varieties are fully as productive as the most prolific pistillate sorts, the fact that pistillate varieties, as a class, are more productive than staminate varieties, as a class, is of academic interest only. For all practical purposes, staminate and pistillate varieties are equally prolific.

[1] Bul. Ohio Exp. Sta., Vol. III, No. 7 (1890), p. 22.
[2] *Ibid.*, Bul. 236 (1912).

Advantages and disadvantages of pistillate varieties.

Pistillate varieties, however, have some advantages. As a rule, their blossoms are somewhat hardier than those of staminate varieties. The superior frost resistance of pistillate blossoms has been observed by too many growers in all parts of the country to be questioned. J. L. Budd explained this fact by the theory, "The development of pollen is an exhaustive process; hence, the ovaries of the perfect varieties are not as well stored with starch and as perfectly matured as varieties of those that have no stamens or pollen." The immunity of pistillate varieties to injury by the weevil is noted on page 272.

On the other hand, it is decidedly inconvenient to be obliged to set pollinizers with pistillate sorts. Solid blocks of one variety are more convenient in every way, especially in harvesting. Careless pickers are likely to mix the two varieties in the box, giving it an uneven, ungraded appearance. If prolonged rains occur during blossoming time, the pollen is not well distributed; under these conditions, pistillate varieties have a larger number of imperfect berries than staminate sorts. In the coast region of British Columbia pistillate varieties are not popular, for this reason.

Pistillate varieties gradually disappearing.

According to U. P. Hedrick, "from 1834 to 1870 there were 185 varieties originated. Of these, 96, or 52 per cent, were pistillate. From 1870 to 1900, 513 varieties were originated. Of these, 156, or 30 per cent, were pistillate."[1] To continue his argument, but 28 per cent of the 482 varieties introduced between 1900 and 1916 are pistillate. Hedrick concludes: "This shows a gradual tendency

[1] "American Gardening," XXII (1901), p. 226.

toward bisexuality." Undoubtedly this is due, in part at least, to cultural preferences. Since it has been demonstrated that staminate varieties can be secured that are fully as productive as the best pistillate sorts, most growers prefer them, because they are more dependable in pollination and more convenient to use. Breeders introduce varieties that growers will want to buy. If the drift toward staminate varieties continues at the present rate, in another century or less all North American varieties will be bisexual; then one of the most confusing phases of strawberry culture will have been eliminated.

SELECTING AND DISTRIBUTING THE POLLINIZER

Many pistillate varieties produce a little pollen and are able to set fruit alone in favorable seasons. Occasionally, some staminate varieties are not able to pollinate themselves perfectly. Crescent is classed as pistillate, yet the first blossoms that open may have well developed stamens; it may become a true staminate on rich soils. Glen Mary and Gandy are classed as staminate, yet the early blossoms frequently are deficient in pollen, and these varieties are benefited by being planted with a pollinizer (Plate X). The number of these semi-perfect varieties is larger than is commonly supposed. Unfavorable weather greatly reduces pollen production. In commercial operations it is well not to rely wholly on the arbitrary classification of varieties as to sex, but to use pollinizers, not only for known pistillate sorts, but also for weak staminate varieties that are likely to be deficient in pollen in unfavorable seasons.

PLATE XI. — Successive stages in the opening of a Brandywine blossom, and the setting of fruit.

Desirable points in a pollinizer.

The pollinizer should be, first of all, a valuable commercial variety. Many standard market varieties are good pollinizers. The pollinizer should produce an abundant supply of pollen, even under trying weather conditions, and at the right time to fertilize the pistillate blossoms. Some pistillate varieties have a longer blossoming season than staminate sorts; if but one pollinizer is used, some of the early or late blossoms will not be fertilized. The benefit from using two varieties as pollinizers, one blossoming somewhat earlier than the other, was shown in the experiments of E. S. Goff:[1] "When Warfield was pollinated with Michel, an early bloomer, 68.8 per cent of the total crop was gathered in the first six pickings. When Warfield was pollinated with Parker Earle, a late bloomer, 56.3 per cent of the total crop was gathered in the first six pickings." In some cases it is desirable to select a pollinizer that ripens at the same time as the pistillate. There is little or no connection between earliness in blooming and earliness in ripening. Local notes on the blooming periods of varieties are necessary. Varieties that blossom together in one locality usually do in another, but not always.

The "mating" of varieties.

With few, if any, exceptions, varieties blossoming at the same time will fertilize each other. Much has been said about the proper "mating" of varieties. In so far as this term refers to the use of varieties that will furnish pollen for all the blossoms of the pistillate sort, early and late, it is well applied; but if used to imply a superiority of one pollinizer over another in other respects, it is

[1] Rept. Wis. Exp. Sta., 1897, p. 28.

hardly justified. The importance that once was attached to this subject, by some, is indicated by a statement made in 1894: "It is probable that every desirable pistillate sort has a good friend among the staminates that it should be married to in preference to others."[1] This view is given little credence now. Matthew Crawford says, "I have never yet seen a case where a pistillate variety refused to be fertilized by any bisexual variety that was near and that bloomed at the same time."

Practically all staminate varieties will not only fertilize themselves and each other, but also any pistillate sort that is planted near them. A. S. Fuller stated that he had seen varieties which bore flowers "that, to all outward appearance, were perfect; still, neither their own pollen nor that of any other varieties would fertilize the pistils, except in rare instances." The Crystal City, or Acme, was said to behave in this way under certain conditions. The Marshall has been shown to be somewhat inclined toward self-sterility; that is, it does not set fruit so well with its own pollen as with that of some other variety.[2] Such instances, however, are so rare as to be almost negligible. Ewert has shown that parthenogenesis, or the production of fruit without fertilization, is common in the strawberry.[3] His experiments lead him to believe that self-sterility does not exist among European varieties.[4]

Immediate influence of pollen.

Can the character of the fruit be influenced by the variety used as a pollinizer? The seeds will be crossed;

[1] Jacob Biggle, in "Biggle Berry Book" (1894), p. 43.

[2] C. C. Georgeson found some of his hybrids between the native *F. chilænsis* of Alaska and a common variety self-sterile.

[3] Landw. Jahrb. 38 (1909), Nos. 5–6, p. 767.

[4] Jahr. Ver. Angew. Bot. 5 (1907), p. 83.

if seedlings are raised, the influence of the male parent will be observed in them, but the seeds are a very small part of a ripe strawberry, usually less than two per cent. Is the influence of the pollen parent exerted on the pulp also, modifying the size, shape, color and quality of the berry? This has been the theme of many heated discussions at horticultural meetings. It was first brought prominently before the public in 1883 by J. L. Budd, who said: "Observations and experiments have fully convinced me that this influence is so marked and positive as to render an entirely pistillate variety, like the Crescent, so totally different when fertilized by two sorts of widely different characteristics that it would not be recognized as the same strawberry." This conclusion was supported by A. S. Fuller. On the other hand, Matthew Crawford, T. J. Burrill, T. T. Lyon and many others, found no immediate influence of pollen. Later and fuller observations have supported this conclusion. It cannot be denied that, occasionally, the character of the fruit may be influenced very slightly by the kind of pollen used, but these instances are so rare that they are not worth considering as a cultural factor.

Distributing the pollinizer.

In planting, the proportion of the pollinizer to the pistillate sort will depend chiefly on the comparative market value of the two varieties and the ability of the former to produce pollen; also, to some extent, on local climate. The proportion has steadily increased. When the use of pollinizers was first urged, about 1845, it was suggested that one be planted to each ten pistillate plants, following the advice of Michael Keens, of England. In 1845 S. S. Jackson, a nurseryman of Cincinnati, sold plants in

bunches of one hundred, with "ninety females and ten males" in a bunch. These were mixed indiscriminately in the row. At that time, however, the pollinizer was considered a dead loss, except to fructify the pistillate plants, and it was natural that the proportion of the pollinizers should be kept as low as possible. By 1885 the proportion was one row of Wilson to five of Crescent. Now, the proportion usually recommended is one to three, occasionally one to two. It may be advisable to set an early blooming staminate on one side of a row of the pistillate variety, and a late blooming staminate on the other side. Growers who live near lakes or large streams, where the air is moist and fogs are common during the blooming season, may find it necessary to make every other row a pollinizer. Pistillate fall-bearing varieties need a larger proportion of the pollinizer than spring-bearing varieties, since the weather during their blooming season is cooler and insect visitors less numerous.

In most cases the pollinizer is set in separate rows. A few growers mix them promiscuously with the pistillate plants. W. S. Perrine, of Illinois, used three to five varieties in the same row. He planted solid rows of a variety diagonally across the field, so that staminate plants alternated with pistillate plants. More recently, L. J. Farmer, of New York, has advised: "I think, for best results, it is best to mix pistillate and staminate varieties in a row, keeping several rows for propagating purposes unmixed." Most growers, however, prefer to plant the staminate and pistillate sorts in separate rows.

PLATE XII. — Nubbins, usually the result of imperfect fertilization, sometimes of insect injury.

WEATHER CONDITIONS AND POLLINATION

Proper pollination is as important with staminate varieties as with pistillates. Few blossoms are self-fertilized, because the pollen and the pistils do not mature together in the same flower. It is necessary for pollen to be transferred from one blossom to another. This is done to some extent by wind, but mostly by insects. Probably over ninety per cent of strawberry pollination is done by insects. The strawberry blossom does not produce much nectar, and bees prefer other pasturage when it is available, much to the loss of the grower.

Nubbins are the result of imperfect pollination or of injury to the pistils; either the pollen did not reach all of the pistils, or fertilization was prevented (Plate XII). Occasionally nubbins result from winter injury or from the work of weevils or other insects. Warm, dry weather favors good pollination. Insects are abundant on the blossoms then, especially the honey bee. Over ninety per cent of strawberry pollination is done by the honey bee, the bumble bee and other wild bees. In searching for nectar and pollen, their bodies become dusted with pollen; this is carried from flower to flower, thus effecting cross-pollination. Cold or prolonged rainy weather is unfavorable to pollination; it prevents insects from working upon the blossoms and may injure the essential organs. Frosts, dry winds, prolonged rains and hail cause many nubbins. Usually frosts injure only the blossoms that are fully expanded at the time. Those that are not opened are uninjured, and the crop is merely a little later in ripening. Nubbins are most abundant late in the ripening season when the pollen supply is likely to be short and the plants are somewhat exhausted.

CHAPTER VIII

PACKAGES

THE packages used for shipping strawberries have changed with the generations to meet new conditions as they have arisen. The evolution of the modern, cheap gift package from the clumsy and expensive return package of earlier days has reflected the rapid development of the industry.[1]

THE STRAWBERRY BOX

When strawberries are grown for a personal market, many types of packages can be used in order to give distinctiveness to the product; but when grown for the general market, the choice is determined largely by the preferences of the market. Buyers prefer the package to which they have become accustomed; they will pay more for strawberries in what is considered a standard package for that market than in an unusual package, however meritorious.

Material.

Probably ninety-five per cent of the strawberries marketed in North America to-day are sold in quart or pint splint or scaleboard boxes. These are made of white

[1] For the history of strawberry packages, see Chapter III in "The Strawberry in North America."

wood (tulip tree), bass wood, spruce, cypress or birch veneer, about one thirty-second of an inch thick. Paper or cardboard boxes have been used to a slight extent. Most of the early paper boxes were unsatisfactory because moisture from the strawberries penetrated the paper and softened it, so that the boxes lost shape before they reached market, and the paper frequently affected the flavor of the berries. Paper boxes coated with wax or paraffin until they are waterproof have been used quite successfully, especially for local trade; they have not been as satisfactory for long distance shipments. Paper boxes look neat and make an attractive package. They usually are shipped nested; some are shipped in the flat and are made up by locking the end. They cost about $2.50 a thousand. Tin cups are used rarely.

Shape and ventilation.

The Hallock box is made of two pieces of scaleboard or veneer, one forming the sides and the other the bottom (Fig. 6). It is square, and the sides and bottom are solid, with no provision for ventilation. There has been much discussion as to whether strawberries carry better in tight or ventilated packages. Experiments in 1904 by the United States Department of Agriculture showed, "The principle of a close package is correct, and such a package will materially prolong the durability of the fruit, provided it is dry and sound." The bottoms of Hallock boxes are elevated one-half inch,

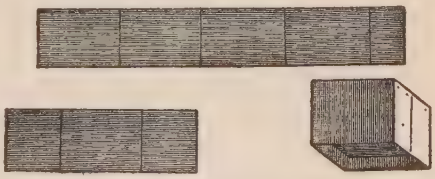


Fig. 6. — Hallock box.

so as to avoid crushing the berries below. There is no division frame between layers. No tight package for strawberries other than the Hallock now is in use, but some northern growers who cater to a special trade wrap each box in parchment paper. This keeps the berries bright and prevents them from absorbing taints. If left on too long, the paper, itself, may taint the berries by preventing the normal exhalations from passing away.

Fig. 7. — American standard ventilated box.

Ventilated or slat crates and ventilated splint boxes — now called "American Standard Boxes" (Fig. 7), have steadily grown in favor, which indicates that ventilation has been found desirable by most shippers. The layers in the crate are separated by partitions, thus permitting free circulation of air around every box. A box with several holes in each side has been put on the market, but experience has shown that the ordinary American box provides enough ventilation. The American box is square, with slightly flaring sides; this is preferable to round or octagonal boxes.

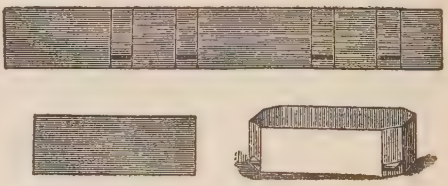


Fig. 8. — Octagonal, or "Leslie" box.

The long octagonal, or "Leslie" box, which has been used mostly in the Mississippi Valley, is the least desirable type. Like the Hallock, it is shipped in the flat; it has notches in the corners where the bottom drops in (Fig. 8). No partitions are used between layers of boxes. The raised bottoms make this unnecessary, and are not, as many consumers suppose,

for the purpose of deceiving them as to the contents. The Leslie box is not economical of space in the crate, and it is difficult to pick up without bending the sides and bruising the berries. The raised bottom often splits off, causing the box to tip over; or it may cup up and drop out entirely. Hallock and Leslie boxes are somewhat cheaper than American Standard boxes, but the latter are more substantial, and most markets prefer them.

Cubic contents.

There has been much confusion about the size of strawberry boxes. The chief difficulty has been the difference between dry measure and liquid measure. In the United States, a legal dry quart contains sixty-seven and one-fifth cubic inches, level measure; a legal liquid quart — commonly called wine measure — contains fifty-seven and three-fourths cubic inches. Berry boxes have been made under both standards and both have sold as a quart of berries. For many years, most markets did not discriminate in price between the dry quart and the wine quart; frequently, dealers would buy berries in dry quart boxes and sell them in wine quart boxes, gaining one quart in five. Recently several states have enacted laws making it illegal to market strawberries in any but standard dry quart or dry pint boxes and the federal government, also, is exerting pressure in the direction. This is forcing growers in the chief producing districts to adopt the standard dry measure box, since a large proportion of their strawberries are shipped to markets where wine quarts are not allowed. From present indications, dry measure will be used exclusively within a few years.[1]

[1] The following states require the use of the United States standard dry measure for strawberries that are shipped or marketed within their

There is no federal law regulating the size of berry boxes for interstate commerce, but the outside of every crate must be marked with its contents in accordance with the regulation requiring that all classes of food must be plainly and conspicuously marked in terms of weight, measure or numerical count on the outside of the covering or container usually delivered to customers. This means that each crate must have the number of boxes it contains, and the quantity stamped on the outside. Canadian growers long have used the two-fifths and four-fifths quart dry measure, instead of the full pint and full quart. They contend that the bulk of fruit in a full quart is too large to insure safe arrival in a distant market without crushing. A British Columbia law requires strawberry boxes to hold one pound net; a pound of berries is about four-fifths of a quart. The full pint basket is growing in favor in British Columbia, the Pacific states and in the South, especially for long distance shipping, early in the season, when prices are high.

A few years ago, four sizes of "quart" boxes could be found in any large market — standard dry, standard wine, scant or short, and skin or snide. The scant quart box, which usually contained $60\frac{15}{16}$ cubic inches, once was used extensively and is still sold. Snide or scalper boxes frequently contained only forty-seven cubic inches. In 1888, snide quart boxes, holding but forty-two cubic inches, were used in New Jersey, until driven out by law. This sharp practice is no longer tolerated. The drift of the times is strongly toward honest measure.

boundaries, that is, a full dry quart, dry pint or half pint: Delaware, Indiana, Iowa, Kansas, Maryland, Massachusetts, Nebraska, Nevada, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Wisconsin.

Dimensions.

The cubic contents of a box may be regulated by law, but the dimensions or shape of the box is a matter of convenience to be determined by the growers and the box manufacturers. At a meeting of the Pacific Northwest manufacturers of berry boxes in 1913, it was recommended that the dimensions of the United States Standard quart box be 5×5 by $2\frac{13}{16}$ inches deep, outside measure; the United States Standard shallow pint $5 \times 5 \times 1\frac{13}{32}$ inches deep; the United States Standard deep pint $4\frac{3}{8} \times 4\frac{3}{8} \times 1\frac{7}{8}$ inches deep.[1] At a recent meeting of eastern box manufacturers it was recommended that American quart boxes should be 5 inches top, from corner to corner inside; bottom $4\frac{3}{8}$ inches from corner to corner; depth $2\frac{15}{16}$ inches. The dimensions of the Hallock and Leslie boxes are: Hallock dry quart 5 inches square, $2\frac{13}{16}$ inches deep. Hallock wine quart $4\frac{3}{4}$ inches square, $2\frac{1}{2}$ inches deep. Hallock pint, as above but one-half as deep. Leslie dry quart, band $3\frac{1}{4}$ inches wide by $20\frac{3}{8}$ inches long; bottom $3\frac{1}{4}$ inches wide $\times$ $6\frac{3}{4}$ inches long. Leslie dry pint, band $1\frac{3}{4}$ inches wide $\times$ $20\frac{3}{8}$ inches long; bottom $3\frac{1}{4}$ inches wide $\times$ $6\frac{3}{4}$ inches long. Several special sizes are sold, as follows: Illinois Hallock pint 5 inches square, by $1\frac{1}{2}$ inches deep. Illinois Hallock quart 5 inches square $\times$ $2\frac{1}{2}$ inches deep. Michigan Hallock pint $4\frac{3}{4}$ inches square $\times$ $1\frac{1}{2}$ inches deep. Michigan Hallock quart $4\frac{3}{4}$ inches square $\times$ $2\frac{1}{2}$ inches deep.

Prices.

The present prices of the different styles of boxes, f.o.b. factory, are given below; usually the price for dry and wine measure boxes is the same. American ventilated quart,

[1] "Better Fruit," Dec., 1913, p. 27.

$3.00 to $3.25 a thousand. American ventilated pint, $2.75 to $3.00; Hallock quart, $2.60 to $2.90; Hallock pint, $2.25 to $2.50; Leslie quart, $2.60 to $2.90; Leslie pint, $2.25 to $2.50. These prices are for American boxes made up, for Hallock and Leslie boxes in the flat. Wire-sewed American boxes are preferable to those made up with tacks. There are, also, several types of folding berry boxes; these are shipped in the flat and are made up without tacks. They cost a little more than the others. The prices of boxes are lower now than ever before. In 1860 splint boxes cost $30 a thousand; in 1870, $15 a thousand.

CRATES

The type of crate to use is determined by the type of box selected, since crates and boxes are sold to fit; also by the market. Substantial, iron-bound, return crates with hinged covers still are used somewhat for local trade (Fig. 9). These cost two or three times more than gift crates. Sectional return crates with two, three or four slat trays — usually three — each holding eight boxes, are useful for local markets. The trays are cleated so as to provide room for heaping berries without mashing them. Each tray may be taken out and displayed separately. Hallock and Leslie crates cost about half as much as

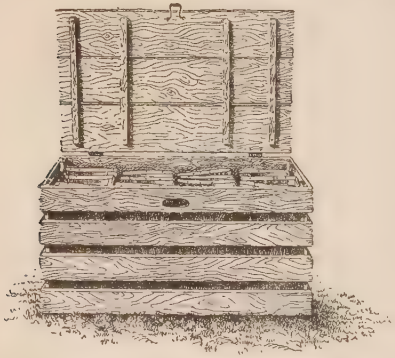


Fig. 9. — Heavy iron-bound return crate.

American ventilated crates, since they have fewer pieces, and no racks or divisions are placed between the layers of boxes (Plate XIII). The covers of most gift crates are nailed on, but it is better to have them hinged with strap iron, as this permits the easy inspection of the crates, which is an aid in making sales. The gift crate should be light, but substantial enough to carry the fruit without damage; some are constructed of very flimsy material.

Size.

The size of the crate, like the size of the box, depends on the distance that the fruit is to be shipped and the preference of the market. The farther the shipper is from market the smaller should be the crate, as the berries carry better. This is the chief reason why twenty-four or sixteen quart crates are used almost universally in the Mississippi Valley and westward, while thirty-two quart crates, or larger, are preferred in the East. Use the largest crate that can be handled conveniently and that will carry the berries safely; the larger the crate the less it costs a box and the lower the expense of packing. The thirty-six quart crate is preferred by some, especially in New York; it is better to make sales from than the thirty-two quart crate, since twelve baskets are exposed to the buyer; but it cannot be handled easily by one man. The largest gift crate now used to any extent is the sixty-quart, which has four layers of fifteen quarts each. This has been popular in the Norfolk district for over fifty years. Two men are required to lift it, so it cannot be banged around like a light crate. The sixty quart size is a convenient unit for the wholesale trade; most retailers in small towns can use that quantity at a time. The sixty-four, forty-

eight, forty-five and thirty-six quart crates are used somewhat in the East, but more eastern strawberries are now shipped in thirty-two quart crates than all other packages. The sixteen and twenty-four quart crates long have been standard in the Mississippi Valley and westward, and in the South, and are gaining favor among eastern shippers. Recently the twelve quart crate has been used somewhat in the Mississippi Valley. The twenty-four pint crate is becoming a standard package in the West and South for extra early or extra fancy berries.

Prices.

The present prices for gift crates, f.o.b. factory, are given below; wine and dry quart crates usually cost the same:

Standard American ventilated,	32 qt.	17½¢
Standard American ventilated,	24 qt.	15¢
Standard American ventilated,	16 qt.	12½¢
Hallock	24 qt.	7½¢ to 8½¢
Hallock	16 qt.	5½¢ to 6½¢
Hallock	12 qt.	5½¢ to 6½¢
Hallock	24 pt.	5½¢ to 6½¢
Leslie	24 qt.	8¢ to 9½¢
Leslie	16 qt.	5½¢ to 6½¢
Leslie	12 qt.	5½¢ to 6½¢
Leslie	24 pt.	5¢ to 6½¢

Associations that buy package material in car-lots secure a considerable discount from these prices. There has been but little reduction in the cost of gift crates since 1880.

MAKING UP BOXES AND CRATES

Boxes, crates and refrigerators should be procured long before the picking season opens. There is a risk in buying

PLATE XIII. TYPES OF CRATES. — *Top*, twenty-four quart Leslie crate of ungraded Arkansas Aromas; *center*, twenty-four pint Hallock crate of well graded Louisiana Klondikes; *bottom*, thirty-two quart American ventilated crate of well graded Missionary from Florida.

a full supply before the picking season begins, as the estimated crop may be cut short by weather conditions; but it is safer to prepare for a full crop than to risk being caught without an adequate supply of packages in the middle of the harvest. The following experience illustrates what may happen if the ordering of package material is left until the last moment.[1] "On account of the lack of berry crates the strawberry shipping at New Albany, Indiana, collapsed early last month. It is estimated that the loss will amount to $100,000. Hundreds of thousands of boxes of berries were left to rot in the fields." If ordered early, box material has a chance to dry out before being used, so that the moisture from crushed berries will be quickly absorbed by the wood without injuring adjacent sound berries. Packages made from material that is not well seasoned will heat.

If the crates and boxes are bought knocked down they may be made up in the winter, thus furnishing profitable employment on stormy days. The crates may be made and filled with boxes, ready for use; or the boxes may be stacked, bottom side up, so that dust will not settle into them. Some prefer not to make up the packages more than two or three days before using them, as they do not look fresh and clean if made up long ahead. Do not use second-hand boxes or crates; even though the dingy ends are covered with colored lithographed labels, this is poor economy.

Methods.

The factories will make up the packages as cheaply as the grower can, but the freight bill will be heavier; most growers find it more economical to do it on the farm.

[1] "American Fruits," I (1904), p. 74.

Hallock or Leslie boxes can be made up by hand for about seventy-five cents a thousand. Hallock quart boxes in the flat weigh 125 pounds a thousand; they are crated in bundles of 500 each. Hallock crates weigh about five pounds each. It takes a little over one pound of two ounce tacks, costing twenty-five cents, to make 1000 boxes. A magnetic hammer, costing twenty cents, is useful. The forms on which to tack the boxes cost fifteen to twenty-five cents.

The Hallock box is made of two pieces of veneering, scored to bend at the corners. The band is bent inward at the groove marks, wrapped around the bottom, and tacked, the short end making the outside lap. Bands cut with fine score marks instead of grooves should be bent outward, away from the score marks. Four tacks should be used on the lap side, two through the lap and two near the corners; also two or three on the opposite side. If the veneer becomes very dry, so that it cracks, it should be dampened. A boy or girl can make 1000 to 1500 boxes a day by hand. One person can put up 4000 to 6000 boxes a day with a stapling machine; stapled boxes are stronger than tacked boxes (Plate XIII). These machines cost about $40, when operated with steam power, and $16 to $20 when operated with foot power. They feed the wire, form the staple, drive and clinch it with one stroke of the foot pedal. Wire costs less than tacks; a coil of stapling wire costing eighty cents will make 10,000 to 12,000 boxes.

One man can make up 150 to 200 Leslie or Hallock crates a day at a cost of about one cent each. Crate forms can be made at home or can be bought for $1.25 each. F. E. Beatty gives the following directions for making the form shown in Fig. 10. "Take a plank two inches thick, six-

teen to twenty inches wide and two feet long. Nail a six inch board to the back of it, then put on one inch strips to form the slots, as shown in the picture. These slots hold the ends and center pieces into their places while the sides are being nailed on." One piece of heading should be placed exactly in the center of the frame and the side pieces should be exactly even with the heading at both top and bottom. Use three-fourths inch No. 16 wire nails; and leave no nails protruding to catch the hands.

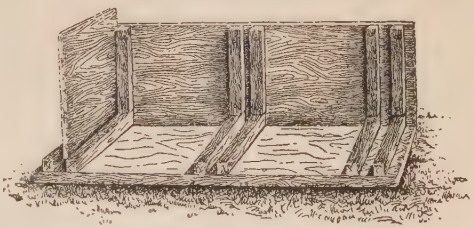


FIG. 10. — Form for making Leslie or Hallock crates.

American crates come knocked down and ready to assemble by nailing the sides and bottoms to the ends. The division pieces or trays come made up. American boxes are shipped made up and compactly nested. They require special machinery to make up and the veneer dries out and gets brittle if shipped in the flat. Several types of "folding" crates for use with American baskets are on the market, but have won little favor as yet. They are shipped folded and require no nailing, either for assembling or for attaching covers.

SPECIAL PACKAGES

Most strawberries are marketed in the packages described above, but a number of special packages are in use. These are of two types; those that furnish refrigeration for berries shipped to distant markets, and those that are convenient for near markets.

Refrigerators.

The most elaborate and expensive strawberry package is the refrigerator box or chest. Refrigerators holding from 32 to 640 quarts of berries and a small quantity of ice were used before 1880 at Charleston, South Carolina, and in Florida. The early experiments with refrigerators by Parker Earle of Cobden, Illinois, are detailed elsewhere.[1] The chief objection to the very large refrigerators was their ponderous weight. Small chests were likely to be thrown, bottom side up, in the express car and did not hold enough ice. The early styles had a narrow, upright receptacle for ice, forming a partition through the center of the box. In all later patents the ice pan covers the entire top. All the berries are cooled evenly, since the cold air near the ice settles to the bottom (Plate XIV). Modern refrigerators are square. The ice pan is of galvanized iron, and occupies about one-third of the inside space. There is a ventilator flue of the same material through the middle. The tiers of boxes are separated by division slats. Practically all refrigerators in use now hold either sixty-four or eighty quarts of berries. The eighty quart size, with five tiers of boxes, is used more commonly than the sixty-four quart size with four tiers. The eighty quart size requires 175 pounds of ice; the sixty-four quart size, 100 pounds. When full of berries and ice the former weighs 250 pounds, the latter 225 pounds. Before the berries are put into the refrigerator they are cooled by placing them in a shady place, or in a cooling room. After the chest has been filled and iced, it is removed to a cool place to reduce the temperature of the fruit before it is shipped. The ice pan is replenished just before the refrigerator is placed upon the train.

[1] "The Strawberry in North America," Chapter III.

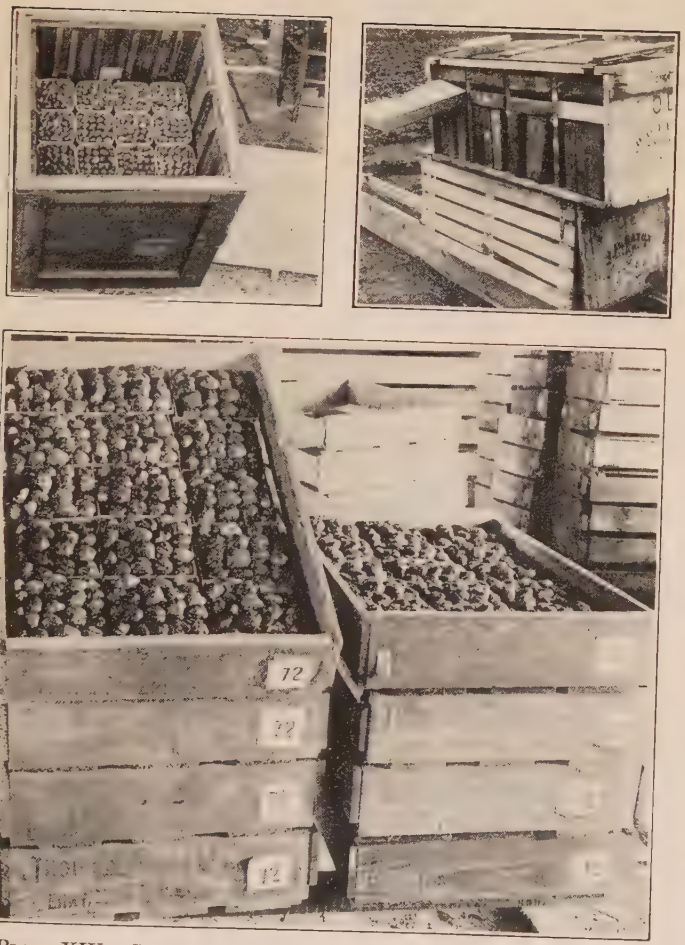


PLATE XIV. SPECIAL TYPES OF PACKAGES. — *Top left*, pony refrigerator, used in Florida, with ice pan removed; *top right*, chest of drawers or slides, used in California; *bottom*, return trays used in southern California.

The refrigerator is a distinct advantage to the grower who has not enough berries to load a refrigerator car. It is used early in the season, when pickings are small and prices high; when the season is at its height, refrigerator cars are used and the berries are packed in American ventilated crates. The refrigerator is shipped by express; it costs six to nine cents a quart to put Florida berries into northern markets. Refrigerators cost four to five dollars each. Most Florida growers now own their own refrigerators, but at one time certain commission men derived a handsome profit from renting them to growers.

California chests.

A stout case holding forty-five pint boxes, with a tray on top holding twenty-five pounds of ice, is used in California. The insulation of these cases is rather poor, but they can travel for twenty-four hours without re-icing. Each grower has his own ice chests and they are returned to him when empty. Ice chests are used when only a few crates are shipped to one place.

Many California berries are shipped in un-iced return chests. The chest used in the Watsonville district costs about three dollars and holds eighty pounds of berries. A chest has twenty slides, or drawers, each of which holds two boxes of berries of two pounds each (Plate XIV). The chest and slides are returned to the grower, the boxes are not. The slides are $15\frac{1}{2} \times 8\frac{1}{4} \times 1\frac{3}{4}$ inches. Smaller chests with ten or fifteen slides are used to some extent. Sometimes berries are shipped loose in the drawers of these chests; this is, essentially, the old Cincinnati stand, which was used by Mississippi Valley growers from 1845 to 1890.

Trays.

Berries destined for near markets are packed in return trays instead of crates; these are described by H. L. Crane, of Westwood, Massachusetts: "We use a 15 quart tray which is $5\frac{3}{8}$ inches deep, $17\frac{3}{4}$ inches wide, and 29 inches long, outside measurement. The ends are made of 5″ planed boards, 5″ × 17″, with handles cut in them as in a bushel box. The sides are of $\frac{3}{8}$″ board, $4\frac{5}{8}$″ × 29″. The bottom is of five pieces laid cross-wise, one inch apart. It is made of $\frac{3}{8}$″ board, 5″ × $17\frac{3}{4}$″. The cover is of five pieces; three long $\frac{3}{8}$″ boards, $4\frac{1}{2}$″ × $27\frac{1}{2}$″, which set inside the box, and two cross pieces which set on the sides; these are $\frac{3}{8}$″ × 17″ × 3″. The ends of the box being $\frac{3}{8}$″ wider than the sides, protects the cross. Trays made of pine cost us 25 cents each. A sheet of wrapping paper placed over the berries keeps out the dust, which would sift through the slat tops. These trays are returned to the local growers. We get about 80 per cent of them back, and the rest are paid for." Trays holding eighteen or twenty-four quart boxes are used, also. In southern California, practically all the berries for local markets are handled in return trays holding fifteen pint baskets (Plate XIV). The names or numbers of the growers are stenciled upon them. These trays cost eight cents each. New England growers who cater to a local market ship their No. 1 berries in trays and the No. 2 stock in crates. Trays are cheaper, and more convenient for local trade than crates; they also show off the berries better in the market. Another advantage is that none of the fruit is crushed by the weight of boxes placed above.

Baskets of woven wicker work have been used somewhat in North America. Pottles, which were shaped like an inverted cone, and flat, shallow punnets were used near

Boston and New York before 1850. About 1870, many strawberries reached Boston in wicker baskets holding forty-six quarts. In 1898, F. G. Tice of Oswego County, New York, shipped his fancy berries in baskets holding six to eight quarts. Baskets are seldom used now; the drift is toward a smaller gift package. There is an opportunity for those who cater to a personal market to increase their trade by the use of distinctive containers. A special four quart crate, provided with handles so that it can be carried home easily, has been used successfully.

CHAPTER IX

PICKING AND PACKING

Because of the very perishable nature of the fruit and the rapidity with which it ripens, timely picking and careful handling are more urgent with strawberries than with most other fruits. The cost of harvesting is the heaviest charge against the crop, amounting in many cases to over $100 an acre annually.

LENGTH OF PICKING SEASON

Primarily, the location and its climate determine the length of the picking season; incidentally, the soil, method of culture, age of plants and time of setting. Proceeding southward, the picking season of a variety lengthens. In latitude 34 degrees it rarely lasts more than three weeks; in latitude 32 degrees it may extend from three to six months. In the tidewater Virginia and North Carolina districts, all the crop is harvested in about three weeks. In southern Florida, strawberries ripen continuously from the first of December until June, but the crop is not marketed after March. In southern Mississippi the season is three months; in the northern part of the state, five weeks. The season of ripening in Florida and the Gulf states is determined very largely by the date of the last freeze or severe frost. This kills the expanded blossoms, and thus delays the picking season

four or five weeks. In the frostless districts of southern California, plants will bear more or less every month in the year, but there are fairly well-defined periods when they bear most heavily. In commercial fields, the plants are allowed to rest a short time in a semi-dormant condition between seasons. The crop can be "thrown" at any time of the year by manipulating the factors of time of setting, irrigation and runner cutting. When the plants begin to slacken in bearing, the runners and leaves are cut off and irrigation stopped. After the soil has dried out and the plants begin to wilt a little, water is turned on and the plants bear again. The influence of altitude on the season of ripening is well illustrated in the Hood River Valley, Oregon. Near the Columbia River strawberries ripen first; those on the higher benches, a few miles distant, ripen a month later.

Weather conditions immediately preceding the ripening of the crop modify the picking season. Some years the shipping seasons of districts that normally come into market consecutively are coincident, with disastrous results. Early, midseason and late varieties ripen practically together in a backward spring. Hot weather hastens ripening, reduces yield and shortens the picking season. Cold weather prolongs the ripening season and gives firm berries. Wet weather retards ripening and makes the berries soft. In the North, the picking season normally is three to four weeks, but it may vary from eighteen to forty days and be two or three weeks earlier or later than normal.

As affected by the age of the plant.

In the South, the picking season is regulated somewhat by the time of planting and the age of the plants. In

the Los Angeles district, the picking season from old plants is continuous for eight months, from April to November or December. The yield is heaviest in May, June and July, but there are profitable pickings throughout the season. Plants set in October or November bear a fair crop from April to the middle of July; some fields have a small crop in the fall also. "In middle and northern Alabama," says F. S. Earle, "plants set in the spring and allowed to form matted rows ripen all their fruit during a period of three to four weeks, as in the North; but if set in summer or fall they develop successive fruit clusters during a much longer period, often scattering the crop through eight or ten weeks, as is the habit of the strawberry farther south. For home use or for local market, this longer fruiting season is a distinct advantage. Where berries are grown for northern shipment, the heavier early picking from the spring-set matted rows will be more practicable." [1] In the North, old fields often bear seven to ten days earlier than new plantings of the same variety, especially if the field was not renewed.

PICKING PROBLEMS

How ripe berries should be when picked depends on the variety, weather, method of training and distance from market. Soft varieties need to be picked greener than firm sorts in order to get them to market in good condition. When the weather is cool, berries may be vine-ripened for near markets, since they are firm; in hot weather they should be picked greener. Redness does not always indicate ripeness. Some varieties color well before they are ripe, or ready to eat. Berries increase in size

[1] Bul. 109, Ala. Exp. Sta. (1900), p. 41.

considerably after they begin to get red; those who pick early, for long distance shipment, lose this advantage. The time to pick is influenced somewhat by the method of training. Hill or hedge-row berries color early; berries from plants in heavily shaded matted rows color late. Small and medium-size berries may be picked riper than very large berries, which color slowly.

The distance to market is the most important point in deciding how ripe the berries should be when picked. Berries ripened on the vines are of better flavor and more attractive appearance than berries picked when underripe. The closer the market, the riper the berries should be when picked. Growers who are within twenty-four hours shipping distance of their markets pick none with white tips. These immature berries do not color up fully by the time the fruit is exposed for sale; they are unattractive and sour. In the home garden, berries should be allowed to become dead ripe on the vines.

When the fruit is destined for markets several days distant, it becomes necessary to pick it somewhat underripe, to secure firmness and to insure that the berries will not be over-ripe when they reach the consumer. Flavor is sacrificed to shipping quality. Some sorts, as the Clark, color well during shipment if picked when they are barely beginning to color; others color scarcely any after being picked. Do not pick any greener than is necessary to get the fruit to market in good condition. Frequently Oregon and British Columbia berries are in refrigerator cars seven to nine days. They can be picked when barely beginning to show color. "Pick the bed daily," advises W. C. Grant, of British Columbia, "removing all berries that show sign of color. When the bed is properly picked, every remaining berry is green;

if any show a trace of color, the work is not thoroughly done. By this method the berries will reach distant markets in prime condition and will color up thoroughly." [1] Texas and Florida berries are picked when about three-fourths red. Farther north, where the growers are close to their markets, strawberries are picked when colored all over and without green tips. If refrigerators are used, berries can be picked riper than if they are shipped in ventilators.

How often to pick.

The rapidity with which the fruit ripens determines how often to pick. During cool weather, two pickings a week may be sufficient. In hot weather, daily pickings are necessary, especially if the fruit is to be shipped to a distant market. If obliged to miss a day or two on account of rain, the next picking will have many soft berries. Pick these in tin vessels and send them to canneries or jam factories. It is necessary to pick them in order to keep soft berries out of subsequent pickings. In the higher altitudes of Montana berries ripen very slowly and frequently are picked but once a week. Weekly pickings are sufficient for everbearing varieties in late autumn. In hot weather, if the field is not picked on Saturday or Sunday, there will be many overripe berries Monday morning. The small grower who caters to a local trade can pick early Saturday morning, and sell the berries the same day; but the large grower cannot ship on Saturday if his market is less than forty-eight hours distant. Some pick very clean on Saturday afternoon, even a trifle under-ripe, and put the fruit into cold storage over Sunday; but in many cases it is safer to leave the

[1] Bul. 17, British Columbia Dept. of Agr.

berries on the vines. This is a personal problem in ethics, not in horticulture; it is as likely to be settled by the appeal of conscience as by the urgency of the need. We can appreciate the ingenuity, if not the ethics, of the strict Sabbatarian who hired Seventh Day Adventists, whose Sabbath falls on Saturday, to pick his berries on Sunday. In most cases — to venture a purely personal opinion — the loss of berries from not picking on Sunday is small compared with the loss in other respects. If Sunday picking is practiced, it should be optional for the pickers; if not, provision should be made for a larger force of pickers on Monday, and special care in grading is necessary to eliminate the over-ripe berries.

Time of day to pick.

Strawberries are picked preferably in early morning, because they are injured by standing in the sun after picking; because they ship better if picked when cool and firm; because it is a more comfortable time of the day for the pickers to work; and, if the market is near, because the berries can be shipped and sold the same day. Whole train-loads leave points in Sussex County, Delaware, for New York, Philadelphia and Boston, before eight o'clock; these berries were picked the same morning. If shipping in refrigerator cars, early morning picking is not so essential. The only objection to picking very early is that the berries may be wet with dew. Divergent opinions are held as to whether this injures their shipping qualities. Berries picked while wet go down quicker in cold storage than those picked while dry.[1] Probably it is safer to wait until the sun has dried the dew, provided all the berries can be picked before it

[1] Bul. 108, Bureau of Plant Industry, U. S. Dept. of Agr. (1907).

gets hot. In hot weather, if it is necessary to choose between picking in the early morning while the berries are still wet with dew or rain, and deferring picking so late that some will be gathered in the heat of midday, pick early. Some growers pick every day, regardless of dew or rain; the pickers are provided with oilcloth or rubber capes. Those who sell a small quantity of fruit in a local market can pick late in the afternoon, place the berries in a cool shed overnight and market them the next morning.

Care necessary in picking.

The fruit is grasped by the stem, which is pinched and broken off a short distance from the berry. The fingers need touch the berry very little, if at all. Watch for the careless or fast picker, who snaps off the berry at the calyx, leaving no stem; snapped berries may bleed and do not carry well. Short stems husband the keeping quality of the berries and prevent them from packing down too tightly in the box. The stems should be of uniform length. For long distance shipping, one-fourth to one-half inch of stem is left; for near markets, from one inch to two inches. Pickers should gather all nubbins and over-ripe berries, which exhaust the plants. Some provide the picker with a separate box for this purpose. Until the introduction of the Wilson, most of the strawberries brought to market were pulled, leaving the hulls on the vines; those that did not separate from the calyx in picking were hulled before being sold. This practice was introduced from England. It was soon found that the labor of hulling was too great to make it practicable and that hulled berries did not ship well. Since 1860 strawberries have been picked and marketed with hulls on.

PICKING RECEPTACLES

Boxes, cups and stands.

In commercial operations, berries are picked into the same kind of box that is used for shipping them, whether they are graded in the field or at a packing shed. For a local market, nine to twenty pound grape baskets are used, with a tin can at one end for culls. Some growers who do not grade give each picker a sixteen or twenty-four quart crate, with the picker's number stamped upon it; when this has been filled, the picker carries it to the shed. In the Pacific Northwest, growers who find it impossible to secure the right kind of help to grade in the field, pick into a specially constructed stand or tray. This is sixteen inches long, ten inches wide, two inches deep at one side and four inches at the other; it holds about six quarts. The legs extend below the bottom three inches and one inch respectively, so that the top is level when the stand is set on the ground. The four-inch side is hinged at the bottom and secured at the top by hooks, so it can be dropped down at the grading table. This picking tray is lined loosely with white oil-cloth so that it can be easily cleaned.

Carriers.

When boxes are used, these are placed in a light handled carrier, also called a tray, picker's stand or "handy." In hot weather, each picker is provided with one carrier; in cool weather two. The most common size holds four boxes, but six, eight, ten and twelve box carriers are used. The larger the carrier, the greater the danger that the fruit picked first will be injured by the sun. The grower should provide at least twice as many car-

riers as there are pickers, so that the pickers need not wait at the packing shed while the full boxes are being removed. Remove the factory dust from boxes with a whisk broom before placing them in the carriers. Do not grasp a full box on both sides when removing it from the carrier; this squeezes the berries. Carriers can be made during the winter for five to seven cents each. F. E. Beatty gives directions for making the carrier shown in Fig. 11: "Take a board $\frac{1}{2}''$ thick, 10″ wide, and 15″ long for the bottom. Nail a lath on each side and on the ends to hold the boxes in place. Use two inch strips, $\frac{1}{2}''$ thick and 5″ long, for legs. Use a piece of barrel hoop for the handle." Many growers prefer carriers without legs, as these catch in the vines; but the legs prevent the carrier from crushing the berries if it is set upon the row. A carrier provided with a strong handle that pickers may rest on is shown in Fig. 12. In the South, especially near Norfolk, carriers are made with board ends and the bottom, top and one side of veneer; the other side is left open for taking out and putting in the boxes. This protects the picked fruit from the sun.

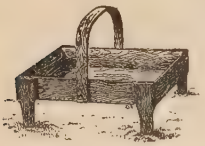


Fig. 11. — The most common type of box carrier, or "handy."

Fig. 12. — Carrier without legs and with stout handle.

In the Pacific Northwest, occasionally berries are carried from the field to the packing shed on a wire or cloth sieve, which allows the sand and dust to fall through. The most elaborate device is the overhead carrier used in the Los Angeles district, California (Plate XV). The entire field is planted; no space is left for roads or paths. Posts

PLATE XV. — Overhead carrier, used in the Los Angeles district, California.

are set across the field 150 feet apart and brackets are nailed to them 6½ feet from the ground. At the ends of the brackets are fastened wires, which run through a pulley. A box large enough to hold two or three crates travels on the wire across the field to the packing shed; there it is unloaded and shoved back to the picker.

SELECTION AND MANAGEMENT OF PICKERS

The control of pickers requires judgment and tact to an unusual degree. Several types of mechanical pickers have been tried, but none has been successful. From eight to fifteen pickers are required to an acre, according to the yield and the skill of the picker. If a long rain is followed by hot weather, more pickers are needed. Have enough so that it will be unnecessary for them to work over eight hours a day; tired pickers are careless. If there are too many pickers, they do not make enough money and become dissatisfied.

Relative value of different types of pickers.

Pickers should be engaged early. If they come from a distance, have camping facilities ready. An advertisement in the want column of the nearest city paper will bring many. Employment agencies may be utilized. Do not take any with defective eyesight or who are physically unfit to do steady work. It is easier to get a large number of pickers to stay through the season than a few.

Most growers prefer women pickers: "Engage your pickers, women first, then girls, and boys last," advises Matthew Crawford. According to O. W. Blacknall, "Women have a better eye for color, nimbler fingers and are by nature more diligent than men. Then, what is

no small matter, they are more abstemious." Small girls and boys are about equally good pickers, if closely watched. Children eight to twelve years old do better work than those between the ages of fourteen and eighteen. One advantage of using men and large boys is that they can pick in rainy weather and early morning, when the vines are wet with dew, or on very hot days; a grower hesitates to ask women and young children to pick under these conditions.

When local help is inadequate, pickers are secured from elsewhere, and camp on the farm. Usually the grower provides camping facilities, including sheds, tents, cook stoves and bedding. In the North Atlantic states, Italians, Bohemians and Poles are used, always with a foreman of their own nationality, who is made responsible; American foremen cannot handle them well. These pickers are always on hand and will work fourteen hours a day if necessary. There are over 10,000 berry pickers in Baltimore alone. From Maryland southward, negro help is used almost exclusively. There are some professional pickers who work in gangs almost the year round, beginning in Texas or Florida and working northward with the season. They will not stay except during the height of the season, when picking is good. These itinerant pickers seldom are trustworthy.

Maintaining the grade.

The greatest difficulty in the management of pickers is to prevent them from filling the boxes with green, over-ripe, small or imperfect berries, and to see that they do not pull or snap the berries from the vines. If the fruit is not graded at the packing shed, extra watchfulness is necessary in the field. Each picker should

wear a badge with his number upon it, and each box in his carrier should be stamped with this number before being taken to the field. This takes little time and makes it possible to trace every box to the picker responsible. When the picker brings his berries to the packing shed at least one box should be examined in his presence. If the work is satisfactory, give him a white ticket; if not, a blue ticket. The names of those who are especially proficient may be displayed on a bulletin board that is hung in the packing shed; this is an incentive to good work. It takes a few days of patient training to secure satisfactory results from new pickers.

Handling pickers.

A wise grower tries to keep his pickers comfortable and contented; otherwise he may have a strike. Nearly every gang has one or more chronic grumblers; these should be detected and discharged. Pay double wage on circus days, and the forenoon of the Fourth of July. Organize sports during the lunch hour. Provide comfortable and sanitary quarters at the camp. Motor trucks may be used to bring pickers from distant towns, and return them to their homes at night. At the close of the season give the pickers a picnic dinner at some near-by lake or resort. These attentions promote good feeling between employer and employees and result in more satisfactory service.

The larger the number of pickers the greater the necessity for system in handling them, so as to make every minute count. If each picker is obliged to wait ten minutes a day for empties, or there is delay in assigning new rows, the aggregate loss of time will be considerable. The pickers should be allowed to vary the monotony of

the work with gossip and repartee, provided they do not play. Pickers require constant supervision; one field overseer cannot look after more than forty pickers. It must be expected that the pickers will eat some berries. The sharp eyes of a field overseer are the best corrective of excess.

The pickers should start in on the side of the field farthest from the packing shed and work toward it. If the field is very large, divide it into sections by setting one or more lines of stakes across the rows; pickers like short rows, and it is easier to look after them if they are close together. When the plants are trained in hills or narrow rows, let each picker have a separate row; wide matted rows may be picked to best advantage by starting a picker between each two rows and requiring her to pick one-half of each. Assign rows according to the capacity of the picker. The field foreman must be certain that each picker cleans the row that has been assigned to her; some may slip over to rows that seem to promise better picking. See that they do not tramp or loll on the vines or walk crossways of the rows. The pickers are obliged to move so frequently that no seat is practicable, although several types of "pickers chariots" have been introduced. Large berries should be placed in the box singly, medium berries by small handfuls, all so gently that there is no sound. Do not pour berries from one hand to the other.

Most growers require each picker to bring the carrier of full boxes to the packing shed; there is less chance of mixing the berries from different pickers, poor picking can be detected and pointed out at once, and the picker is relieved from her cramped position for a short time. When this is done, it is desirable that each row be num-

bered conspicuously with painted stakes, so that the picker may readily find her row when she returns. Provide each picker with a small white stake, with her number stamped on it, to mark the point where she leaves off picking. When it is desirable to keep the picker at work without interruption, she calls "Box," when her carrier is full, and a man gives her a ticket and takes it to the shed.

ACCOUNTS WITH PICKERS

Four methods of keeping accounts with pickers are used; cash at picking time, day-book records, redeemable checks and redeemable punch tickets.

Cash, day-book records and checks.

Very few growers pay cash to pickers as they bring in the berries; this is inconvenient and the pickers may lose their money, but there is no chance for mistakes or forgery of checks. A few growers pay by the hour. Day book accounting is practicable only when there are less than fifteen pickers. A record is kept of each picker by the tally man at the packing shed, thus:

Sam Jones

May 5	65 quarts.
May 6	54 quarts.
May 7	80 quarts.

The pickers are paid once a week, or at the end of the season. This saves much time, but disputes may arise as to the accuracy of the records.

Small cards or checks have been used more than any other method of accounting but are now superseded by punch tickets, except when the number of pickers is less

than twenty-five. Checks are pieces of cardboard about one inch by two inches, with the name of the grower printed on one side, together with the number of quarts it represents; thus:

J. M. Smith
4
Green Bay, Wis.

Checks should be printed in denominations most convenient for the pickers, as one quart, two quarts, four quarts, sixteen quarts, twenty-four quarts and one hundred quarts. Sometimes aluminum checks, called "strawberry money," are used. If a four quart carrier is used, in printing 1000 checks 600 might be four quart, 200 one quart and 200 two quarts. There should be, also, some 50 quart and 100 quart checks, to be exchanged for smaller numbers. The several denominations should be of different colors, to prevent mistakes. The checks are redeemable in cash at the discretion of the grower.

The chief objection to check accounting is that the pickers may lose some of them. In this case he loses his pay, as the grower has no record of the persons to whom they are issued. Neither does the grower know how many checks he has issued, except by counting the number of baskets picked. A dishonest picker may steal the checks of another picker, or print more like them. A method used by M. A. Thayer of Wisconsin meets these objections. He says, "These checks are $1\frac{1}{2} \times 2\frac{1}{2}$ inches, 5 to the page, perforated and bound in books of 500 each, making a convenient pocket check book. They are numbered consecutively, and a check is used but

once. By noting the number on the first check used, and at any time deducting same from the next check to be issued, one can determine just how many boxes have been paid for." [1]

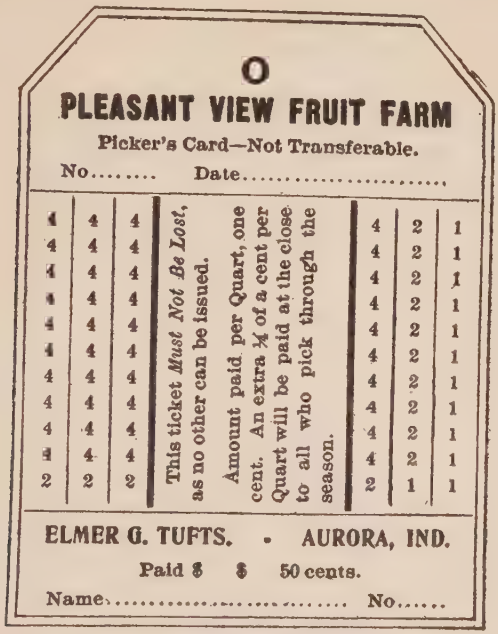

O
PLEASANT VIEW FRUIT FARM
Picker's Card—Not Transferable.
No..... Date.....
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
4 4 4
2 2 2
This ticket Must Not Be Lost, as no other can be issued.
Amount paid per Quart, one cent. An extra ¼ of a cent per Quart will be paid at the close to all who pick through the season.
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
4 2 1
2 1 1
ELMER G. TUFTS. • AURORA, IND.
Paid $ $ 50 cents.
Name..... No.....

FIG. 13. — Common type of punch ticket.

Punch tickets.

This is the standard method in large operations. It meets all the objections that have been raised to checks. Some of the more common type of punch tickets are shown in Figs. 13 to 16. They are printed on tough Manila tags, about $3\frac{1}{2} \times 1\frac{1}{2}$ inches. Usually two tickets

[1] "American Gardening," 1897, p. 392.

are provided for each picker, a daily and a weekly ticket. The daily ticket is tied to the picker's left arm above the elbow, where it is out of the way. When she delivers boxes of fruit in satisfactory condition the inspector registers the number of quarts with a conductor's punch. At the close of each day's picking the number of boxes

Monday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	0	6
Tuesday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Wednesday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
			6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96

Thursday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Friday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Sunday	R		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

HELLER TALLY CARD

Date..... 190..

No. ..... Picked by

M .....

Picked for

M .....

1	2	3	4	Thur.														
1	2	3	4															
1	2	3	4															
1	2	3	4	Fri.														
1	2	3	4															
1	2	3	4															
1	2	3	4	Sun.														
1	2	3	4															

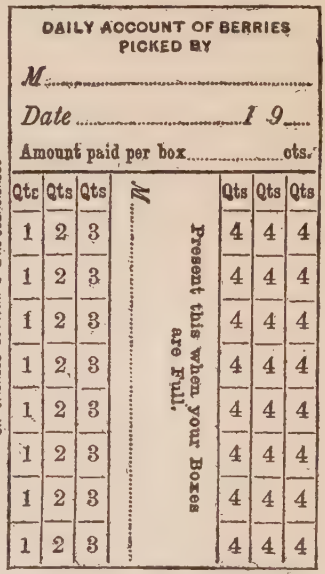
Mon.	4	4	3	3	2	2	1	1										
	4	4	3	3	2	2	1	1										
Tues.	4	4	3	3	2	2	1	1										
	4	4	3	3	2	2	1	1										
Wed.	4	4	3	3	2	2	1	1										
	4	4	3	3	2	2	1	1										

FIG. 14. — The Heller tally card.

picked that day, as shown on the daily ticket, is transferred to the weekly ticket. The daily ticket is then taken up by the grower and filed away for record. The weekly ticket is kept by the picker until she is paid in full, when it is taken up by the grower as a receipt. By preserving the weekly tickets he has a complete record of the picking for the season. The daily ticket should represent about 150 boxes, in convenient denominations. The weekly ticket should have space for the name and

number of the picker, the price paid a quart, the date on which it ends and the cash paid at the close of that week. If the picker loses his weekly ticket, the grower has the daily tickets to check it. Each picker should be required to write his name on the weekly ticket in ink; then if it is lost, no one else can collect on it, for the name cannot be erased without detection. Some growers make the ticket payable to the picker whose name is written on it, so that no one else can collect on it.

Another satisfactory method is to give the picker a ticket, and retain a duplicate, of a different color, at the packing shed. When the picker comes in, the two are placed together and punched; there can be no dispute thereafter as to the number of boxes delivered.


DAILY ACCOUNT OF BERRIES PICKED BY

M.....

Date.....19....

Amount paid per box.....cts.

Qts	Qts	Qts	M	Qts	Qts	Qts
1	2	3	Present this when your Boxes are Full.	4	4	4
1	2	3		4	4	4
1	2	3		4	4	4
1	2	3		4	4	4
1	2	3		4	4	4
1	2	3		4	4	4
1	2	3		4	4	4
1	2	3		4	4	4

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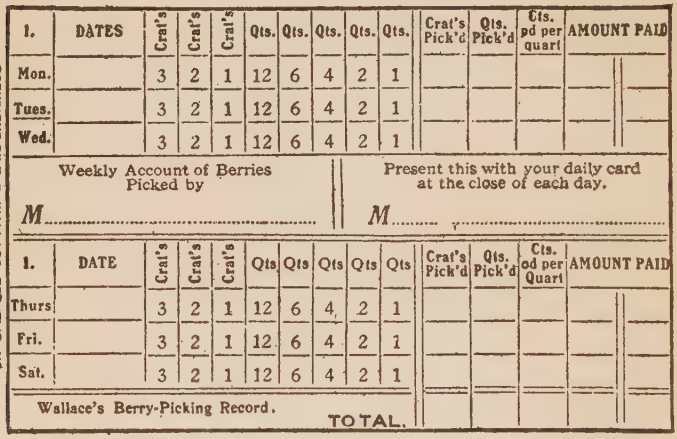
FIG. 15. — The Wallace Berry Picking Record, daily ticket.

Prices.

How often to pay off is mainly a matter of expediency. Some pickers require a weekly settlement; others can be carried to the end of the season. In some of the large shipping districts the growers issue aluminum "strawberry money" which is accepted at face value by local stores. If the picker is paid in full each Saturday, he may not return on Monday. A better way is to withhold one-quarter

cent or one-half cent a quart until the end of the season. A contract to this effect may be printed on the back of the tally card.

The cost of picking ranges from one to three cents a quart, according to the abundance of the fruit, and how much the pickers can make in a day. It is best to establish a uniform price for the season, and require all pickers



1.	DATES	Crat's	Crat's	Crat's	Qts.	Qts.	Qts.	Qts.	Qts.	Crat's Pick'd	Qts. Pick'd	Cts. pd per quart	AMOUNT PAID	
Mon.		3	2	1	12	6	4	2	1					
Tues.		3	2	1	12	6	4	2	1					
Wed.		3	2	1	12	6	4	2	1					

Weekly Account of Berries Picked by

M.....

Present this with your daily card at the close of each day.

M.....

1.	DATE	Crat's	Crat's	Crat's	Qts	Qts	Qts	Qts	Qts	Crat's Pick'd	Qts. Pick'd	Cts. od per Quart	AMOUNT PAID	
Thurs		3	2	1	12	6	4	2	1					
Fri.		3	2	1	12	6	4	2	1					
Sat.		3	2	1	12	6	4	2	1					

Wallace's Berry-Picking Record. TOTAL.

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FIG. 16. — The Wallace Berry Picking Record, weekly ticket.

to remain; a change in price in the middle of the season makes the pickers dissatisfied. The standard price in most sections is two cents a quart. Few growers could persuade their pickers to agree to the plan adopted by some Missouri growers in 1897. They paid one and one-fourth cents a box to pickers who remained the entire season, provided the berries netted $1.75 for a twenty-four quart crate; if more than this, one and one-half cents a box; if less, or if the pickers got tired or were discharged, one cent a box.

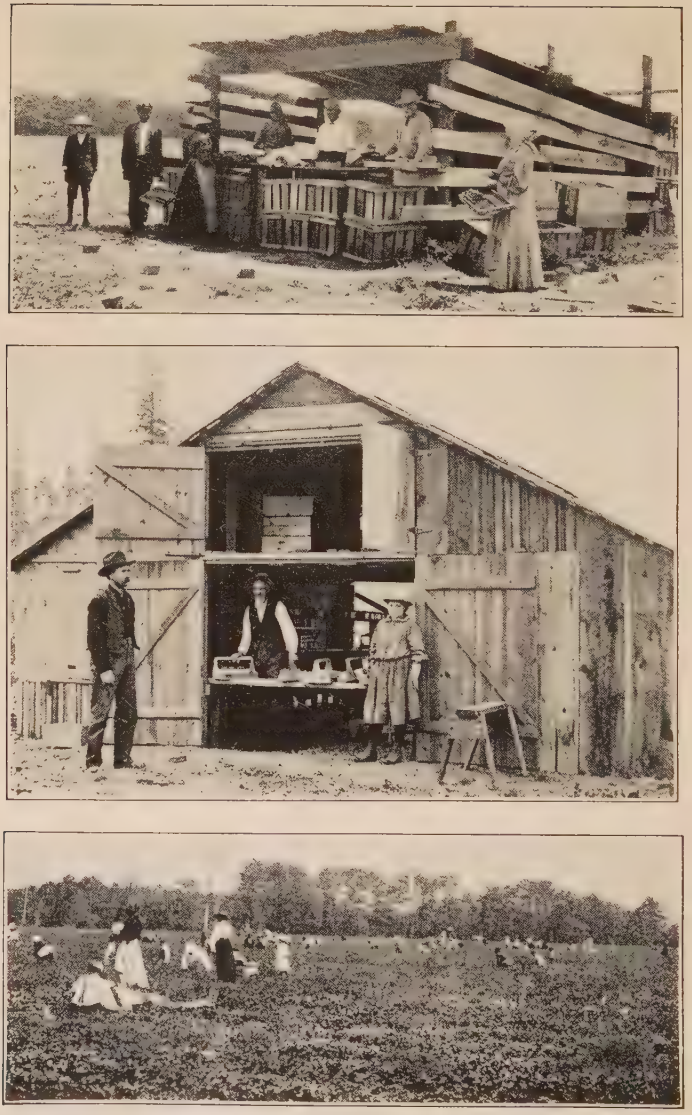

PLATE XVI. PACKING SHEDS. — *Top*, at Norfolk, Virginia; *center*, at Vashon, Washington; *bottom*, harvesting scene, Norfolk, Virginia.

In Florida and southern California, the harvest extends over a long period and the daily pickings are not heavy; hence it often is necessary to pay three cents a quart. In late autumn, everbearing strawberries ripen very slowly and three cents is a fair price. Toward the end of the season, when berries run small and prices are low, allow families to go into the field and pick on shares, giving them one quart in four. In this way no money need be paid out and part of the crop is disposed of at a fair profit.

GRADING

The grading of strawberries is mostly a development of the past ten years. Before then they were shipped, for the most part, about as they were picked from the vines; only the nubbins were rejected. Whether the berries are graded in the field or in a shed, or not graded at all, it is necessary to have some kind of temporary receiving station where they can be examined and put in the shade as soon as possible. For field grading, the sheds should be located where the pickers can bring in the berries most conveniently; there should be one shed for every four or five acres.

Secure as cool a location as possible; hot fingers "muss" the berries. Most packing sheds are temporary, inexpensive structures. It is essential that there should be free circulation of air and protection from the sun. The side that is open to receive the fruit should face the north; the other sides should be boarded down to within two feet of the ground. Plate XVI shows common types of sheds.

Topping.

Strawberries were "topped" many years before they were graded. Grading is an attempt to have all the

berries in the package approximately uniform in size, color and freedom from defects; topping may be merely placing a few choice berries on top of a box of inferior berries in an attempt to deceive the buyer. The deaconing or topping of strawberries has been as common as the over-facing of apples. At one time Florida growers used Hoffman to face boxes of Newman; many crates have been sent to market with Crescent on the bottom and Bubach on top. Growers who place the best baskets on the top of the crate and all the best berries on the top of the box overreach themselves. The standard in packing is rising constantly, not only as a matter of moral conviction, but also as a matter of policy. Dominion, provincial, federal, state and municipal regulations are exerting pressure in this direction.

Field grading.

In Florida, the Gulf states, the Ozark district and the Pacific Northwest, most of the output is graded at the packing shed; elsewhere, mostly in the field by the pickers. Field grading is more economical than shed grading, provided the pickers can be trained to do it properly. After they have become accustomed to it, they will pick and grade nearly as many quarts a day as if all berries went into the same box. The fruit is handled less; every time berries are touched they are hurt for shipment. The berries are shaken down tightly by the picker in moving the carrier about; if they are sorted at the shed, they may be left in the boxes rather loose and will settle on the way to market, unless tightly faced. Field grading makes it possible to put the berries in a cool place very soon after they are picked.

Rarely is it practicable to make more than two grades

in the field; separate boxes are provided for these. If only one grade is made, pick the culls also and put them in a separate box. In this case the pickers should be paid the same price for culls as for No. 1 stock; then there is no inducement to mix culls with good berries. When two merchantable grades are made besides the culls, some growers pay the pickers more for the smaller grade than for the larger. If field-graded berries are faced, this may be done by the pickers, also, but it is preferable to do it at the shed. The top layer may be merely rearranged to give it an attractive appearance; or it may be faced uniformly, as detailed on page 178. Do not let pickers carry large strawberries in their hands or aprons to top off with, as this destroys the gloss.

Each box of field-graded berries, or at least one box from each carrier, should be examined at the packing shed. Take the box in the left hand, place the right hand over the top and gently tip the box over far enough to see that the berries on the bottom and in the middle are as good as those on top; then allow the berries to fall back into place gently with a reverse movement.

Shed grading.

When the fruit is to be shipped a long distance or when the pickers cannot be trusted to do the work well, shed grading and packing are necessary. In Florida, the fruit ripens very slowly during the winter months; it is necessary to inspect each berry to be sure that it has not been gnawed by insects.

Berries are graded to remove defective specimens and to secure uniformity in size and color. Berries of medium size sell well if uniform; if a few large ones are mixed in, they detract from the appearance of the package. Ripe

berries should be sorted out and sold in near markets; under-ripe berries are shipped, and the off-grade stock used for by-products. Usually, from five to ten per cent of the berries as they come from the field are culls.

Following are the grades of the Ozark Fruit Growers' Association:

"'Fancy' berries shall be superior in size and general appearance and in addition possess the following characteristics:

1. "The berries must be at least two-thirds or three-fourths colored.

2. "They must be sound, dry and of good form.

3. "The stem should be from one-half to three-fourths inch in length.

"'No. 1' berries are those not up to the standard of Fancy, yet possessing the common characteristics required for Fancy in rule 2 above; also in rules 1 and 3, but perhaps in a less marked degree.

"All berries not passing either of the above grades shall be rejected and will revert to the owner for disposal as he may direct."

Shipping Associations in the Pacific Northwest allow nothing smaller than five by five berries to go into the Extra Fancy or Fancy grades.

Some years ago, Florida and South Carolina growers used a grading machine consisting of an endless apron as wide as a quart box, revolving on wooden rollers. Machine grading now has been discarded. One of the simplest methods of hand grading is to spread a box of berries upon a sheet of manila paper about two feet square. It requires a knack to spread out the berries at one motion, so that they will not touch each other. The fancy berries are then picked out and put into one box,

PLATE XVII. PACKING AND SHIPPING. — *Top right*, three tier Clarks, W. J. Davis, N. Yakima, Washington; *top left*, method of stripping crates in ventilator cars; *bottom*, Florida berries, fancy grade on *right*, No. 1 grade on *left*.

and the second grade into another; then the culls, leaves and dirt are put into the garbage box. Grading frames are now used almost exclusively. In the Pacific Northwest, the more common type is a wooden frame three feet square, or three feet by four feet, two inches deep, with the bottom of netting or wire screening. The berries are spread thinly upon it and the two grades are picked out by hand. Florida growers prefer a frame one foot by four feet, with the bottom of wire netting covered with coarse burlap. In Missouri, a flat, shallow tin "culling scoop" is preferred. This tapers from ten inches in width at the handle to about $4\frac{1}{2}$ inches at the other end and is twelve to fourteen inches long. It is provided with a receptacle for a strawberry box at the small end. Whatever the form of sorting receptacle used, the object is to expose all the berries so that the culls may be taken out without unnecessary handling of the salable stock.

As they come from the field, the berries are likely to be more or less sandy if the plants were not mulched. Florida growers brush them gently with feathers after they are spread upon the sorting frame, and the sand sifts through the coarse burlap. Years ago berries were washed much more than at present. One of the best methods has been described by J. McHannon: "Make a number of boxes, each ten or twelve inches square, with sides and ends only; for the bottom, use a piece of wire netting with a one-fourth inch mesh. Sink the boxes in a tub of clean water level to the top. Pour the berries into the water over the boxes, which should be raised and lowered two or three times. They need not remain in the water over a quarter of a minute. By pouring so that they fall in the water, they are not bruised at all." At present, berries are seldom washed. Washing takes

much time, and injures the shipping qualities of the berries; mulching is cheaper and equally effective.

PACKING

Berries are packed by the sorter, but sometimes the facing is done by another person. The box is filled nearly full with uniform berries and is tapped or shaken several times to settle them. After it is about half full, the berries are placed stems down so that the top layer will be level for the facers. Fill the boxes solidly, especially at the corners, or they will settle and be short weight. Only the facing layer is aligned.

Facing.

The object of facing, or "plating," is not to put all the best berries on top, but to make the box present an attractive appearance and to pack the berries so they will not be shaken in transit. Facing is essential if the berries are to be shipped a long distance; it is desirable even when they are to be sold in a near market. Boxes are faced by packing the berries in the top layer tightly together. Round-conic berries, like the Clark and Aroma, are faced point up; this makes an attractive plate provided the tips do not remain green. Long berries, like the Haverland, are faced on the side, with all stems lying in one direction. Never face with stems up, as the hulls hide the berries. Varieties that have attractive green hulls should be placed on the side, as these add to the appearance of the face. Do not press the berries; simply lay them in snugly. The facing layer should be not over three-eighths of an inch above the top of the box, since boxes properly packed do not settle much. Any

berries that project beyond the side of the box will be crushed and the boxes stained. If the boxes are not faced, it is necessary to heap them slightly, so that they will be level when they reach market. Fill them so full that they will be gently pressed down when the cover of the crate is nailed on.

Usually the facers are placed so that they will fit together tightly without regard to alignment, but in some districts, especially in the Pacific Northwest, they are aligned each way, making four by four, five by five, or four by five tier boxes (Plate XVII). This cannot be done unless the berries are quite uniform in size. Berries smaller than five tier should not be packed. If strawberry leaves are placed on the top boxes, do not let them project from the crate. One packer can sort and pack twelve to twenty twenty-four quart crates a day. Northwestern growers usually have one packer to three pickers. The price paid for packing at Plant City, Florida, is one cent a quart box; at Vashon, Washington, ten cents a twenty-four quart crate; at Hood River, Oregon, the person who faces but does not pack, is paid one-half cent a box. Each packer is furnished with a rubber stamp bearing his number, which is placed upon each crate he packs.

Piece packing.

The larger growers in the Ozark district pack by the piece system. The packing shed force is divided into cullers, packers, graders and shed inspector; about two-thirds of the force cull and grade. The culler empties each box of berries as it comes from the field into the tin culling scoop, picks out the small, green, sandy, over-ripe and defective specimens, and puts those that remain back into the box from which they came. The packer

then shakes the box to settle it, adds more berries to fill it out at the corners, makes the top layer solid, and places it in the crate. The grader then determines from the size, appearance and "run" whether the crate should be branded "Fancy" or "No. 1." Those who grow fancy berries for a personal market give extra touches. Each box may be wrapped in a sheet of thin parchment or paraffin paper. This keeps out dust, and the berries carry better and keep their bright color longer. The paper is drawn over the box tightly, so that the berries do not shake, and the fruit shows through, making a very attractive package for a special trade. When berries are sold in the general market, the top layer in the crate may be covered with a single sheet of paper.

Cooling.

The sooner berries are placed in a cool place after they are packed the better they will carry. The crates are placed in a cool part of the picking shed until a load is ready. If the interval between packing and shipping is long, a cooling room should be provided. A shed or side hill cellar may answer the purpose, especially if the walls are insulated. Place the crates on the floor, one layer deep, upon two by four inch scantling. Take the covers off or turn them cleats down, so that the air will circulate freely; but keep off sun and wind, both of which discolor berries. After they have been exposed in this way through a cool night, the berries carry better than if they had been shipped the day before, while still warm from the vines. Irrigation water may be run on the floor of the cooling room. Various types of ice-cooled rooms are used to a slight extent. If possible, maintain a temperature of forty-five to fifty degrees in the cooling room.

The covers to the crate should be fastened on securely, with twopenny nails. This should be done on a solid place, so that there will be little jar. Do not scrawl on the crate with a colored pencil; use a neat rubber stamp or stencil. The name of the grower, the variety and the grade should be stenciled upon each crate. Take the crates to the depot on spring wagons. Time devoted to making a smooth road bed between packing shed and depot is well spent.

CHAPTER X

MARKETING

Most men find it more difficult to sell strawberries to advantage than to grow them. The business instinct is not necessarily associated with the cultural instinct; in fact, the two faculties seldom are present to an equal degree in the same person. There have been marked changes in selling methods since the beginning of commercial strawberry-culture. Until about 1840, each grower was obliged to peddle his fruit from house to house. Now a large proportion of growers delegate the sale of their fruit to business men employed for this purpose. Before 1840, the radius of strawberry-culture from the market was limited by the distance that could be covered in a few hours with the market wagon. The remarkable expansion of railroads between 1850 and 1870 made it possible to grow strawberries at greater distance from market. At that time, strawberries were shipped almost wholly in express and ventilator cars, and 600 miles was considered the limit of safety. By this time the commission man had become a necessity. The first successful use of refrigerator cars, in 1887, provided a means of transportation that has made it possible for the grower and consumer to live still farther apart, and has made necessary other intermediaries between the two.

There are two main types of markets; the general or

wholesale, and the personal or retail. In the former, the grower does not deal directly with the consumer. He sells or consigns to a wholesale dealer, who parcels out the fruit to various retail dealers or grocers; these sell it to the consumer. Sometimes there are three or four salesmen between the grower and the consumer. This is the only type of marketing that is practicable in large commercial operations, especially when the fruit is grown at a considerable distance from the market. A grower has a personal market when he sells to the consumer or to a retailer. It is used only when the amount of fruit is comparatively small, and chiefly by growers who live close to towns and small cities. It is essential that the grower shall decide, before he enters the business, to which type of market he will cater. His choice of location, varieties and methods of culture will be determined largely by the market sought.

THE PERSONAL OR RETAIL MARKET

For the small grower, a personal market in a near town is preferable to a wholesale market in a distant city, because he runs less risk. It is a mistake for the small grower to consign express shipments to middlemen in distant cities; transportation charges and commissions eat up the profits. There are thousands of towns with a population of 500 to 5000 where the strawberry-eating habit is comparatively undeveloped. The average town of 500 to 1000 people will use fifteen to twenty-five twenty-four quart cases a day during the berry season. The man who grows berries for a town of 5000 will find that two acres, intensively cultivated, are enough for a beginning. This should provide 10,000 to 20,000 boxes and

keep two delivery wagons busy. It is a mistake to ship the best berries and try to sell the second grade and culls locally.

Selling through retail dealers.

The most satisfactory method, when not more than five acres are grown, is to arrange with a grocer or fruiterer to retail them. If the town is small, give one man exclusive sale; in larger towns, have three or four representatives. The wholesale dealer has a commission of six to ten per cent, but the retailer must have twenty per cent to make a profit. Put an advertisement in the local papers, directing consumers to the dealers who handle the berries. Elmer G. Tufts, of Indiana, tells of the methods that have been successful with him:[1] "Arrange with three or four retail grocery men or fruiterers to sell your berries. Watch the wholesale market and price the berries to them ten to twenty cents a crate higher. They should be paid a percentage of the retail price. Deliver the berries every morning, if possible, and establish the retail price for that day; do not allow the retailer to sell for less without your consent. The same grade of berries should be sold at the same price at all the stores. If it becomes necessary to reduce the price during the day, telephone each retailer. When berries are scarce, divide them among the retailers fairly. If there is a glut, make the price low enough so they can sell the berries anyhow. Use the sectional trays which can be taken apart to display the berries. In the bottom of every quart of the two better grades put a neatly printed card, giving your name and address and where the same kind of berries can be secured each day."

[1] Rept. Ind. Hort. Soc., 1903, pp. 90–4.

The card is shown below:

> These berries are grown by
> A STRAWBERRY SPECIALIST
> You can secure a fresh supply every
> day by buying those grown by
> ELMER G. TUFTS
> *Aurora* Indiana.

If part of the crop is sold to consumers at the farm, the price should be the same as that charged by the town dealers. Some growers provide the retailers with inexpensive wire box carriers, each holding two boxes, so that the buyer can take them home easily.

House-to-house selling.

Special conditions are necessary for success in selling direct to consumers. Rarely is it practicable when more than two acres are grown. There are a number of advantages. The grower secures the retailers' profit and saves part of the expense of baskets and crates. The berries reach the consumer quicker and in better condition. On the other hand, direct sales involve much additional labor; some other part of the work may be slighted, especially the packing, and there are sure to be some bad accounts.

Some of the essentials to success in house-to-house selling have been stated by R. M. Kellogg: "Have a beautifully painted wagon, a shiny black horse and heavy, brass-trimmed harness, kept polished like gold. Have a four-page circular printed in two colors describing what will be offered; hand this circular to every lady in the

town. Put a conspicuous advertisement in the local papers. Then have some family tickets printed, so that each family will be able to keep its own account and will need to pay but once a week. Have different varieties to tempt different appetites. Cut prices when consumption lags. It is hard work, but it pays; you may be able to get three or five cents more a quart than if you permitted local grocerymen to handle them." The motor truck has largely superseded the horse and wagon for this purpose. The grower who seeks a personal market should have neat business stationery, attractive labels, and adopt any other practicable advertising devices. The success of sales direct to consumers depends chiefly on the personality of the grower. He must not only grow good berries, but also be a good advertiser and business man. Comparatively few are fitted for this arduous undertaking.

MEANS OF TRANSPORTATION TO THE WHOLESALE MARKET

Strawberries are shipped to a wholesale market by express, ventilator cars, refrigerator cars and by boat. It is imperative that they reach the market before four A.M., so that they will be ready for the early morning trade. If the supply is heavy, prices may drop twenty-five cents a crate between five A.M. and seven A.M.; by eight o'clock the market is practically over for the day, and berries arriving late may be sacrificed to peddlers.

Express.

When there is less than a carload, the crates are shipped by express. Express is used chiefly for small shipments early in the season, when the pickings are light and prices

high. Express is the most rapid means of transportation, but sometimes the rates are so high as to be almost prohibitive. The crates may be handled roughly, since they are loaded and unloaded hurriedly, while the train is waiting. No provision is made for spacing them in the car, so as to insure ventilation. Strawberries can be shipped by express without refrigeration when they will reach the market within twenty-four hours. If the weather is cool and dry, express shipments may be on the road forty-eight hours, but the risk is great. In warm weather, small quantities of berries are shipped by express in refrigerator chests, particularly from Florida and California. It is safer to use refrigerators if the fruit is to be on the road more than twenty-four hours; but strawberries have been shipped successfully in refrigerator chests from Hood River, Oregon, to Hong Kong. The name of the grower should be stenciled on the upper left hand corner of the cover. The name and address of the consignee should be stenciled plainly on both ends of every crate. The crates should be stout and securely nailed; the light gift crates frequently break in shipment.

Ventilator cars.

These are used for shipping car-lots of berries to points not over forty-eight hours distant; in hot weather, not over twenty-four hours. They have screen-covered vents which, if kept open, give a circulation of air inside the car. If the air circulates freely, the berries carry somewhat better than by express. The cars are filled four to six tiers high, according to the size of the crates. The berries in the top tier carry poorest, because these crates rock most. Even districts that are comparatively close to market, as the Delaware-Maryland peninsula,

use refrigerator cars more than formerly. Many railroads run special strawberry trains of ventilator and refrigerator cars on passenger schedule and do not load them down with other traffic.

In loading a car the crates should be braced, so that they will not shuffle, and so that there will be an air space around each crate. The method is described by F. S. Earle:[1] "Begin the load in either end by laying down a row of packages with their ends snug against the end of the car, but with three to six inch spaces between them. Two half-inch strips, as long as the car is wide, are laid down on the row of packages, one at the front and one at the back (Plate XVII). These are nailed down by a small nail driven into the ends or heads of the crates or boxes. Another layer of packages is placed on these strips, taking care to put each box directly over the one below it, so as to preserve the air spaces from bottom to top of car. Strips are nailed on these as before, and other layers of packages are added until the desired height is reached. Another tier is then started in the same way, taking care to jam the ends of the packages squarely against those of the front tier, so as to preserve the air spaces intact, not only from top to bottom, but also from end to end of the car. When the car is in motion a current of air comes in at the front end ventilators and passes through between the tiers of packages without interruption, and escapes at the rear ventilators. Side ventilation is usually provided also; but it is much less important than that from end to end.

"When the middle of the car is reached it becomes necessary, unless the packages chance to closely fill the space, to brace the piles solidly to prevent their shifting

[1] U. S. Dept. of Agr. Yearbook, 1900, pp. 442–3.

by the bumping of the cars in switching or in starting and stopping. This is done by placing pieces of six-inch fence boards upright against each tier of packages, on either side, and reaching from the floor to the top of the car. Stout cross-strips are nailed to these uprights a foot or so from the floor and from the top. Braces are sawed about an inch longer than the measured distance between these opposing sets of cross bars. The brace pieces are put in place and are driven forcibly home. This settles the load together very solidly. The braces are toe-nailed in place to prevent the possibility of their becoming loosened and dropping down. When thus loaded, nothing short of a collision can cause the load to shift; yet no two packages are in contact except at the ends, each being surrounded by a rapidly moving current of air as long as the car is in motion."

When twenty-four quart crates are used, a load is 510 to 600 crates, occasionally 630, other sizes in proportion. The smaller the load, the better it will carry. Recently some railroads have reduced the minimum load from 15,000 to 12,000 pounds.

Refrigerator cars.

More than half of the berries that are marketed are shipped in refrigerator cars. The time that strawberries can be held in them depends on the conditions under which the fruit was grown, the variety, how ripe the berries were when put into the car, the package used, and the care in loading and icing. Ordinarily, it is safe to hold them four or five days; under very favorable conditions they can be shipped to markets six to ten days distant. Hood River Valley growers sometimes ship Clarks to Alaska and to New York and Boston. In 1914

strawberries were shipped from the Tangipahoa district, Louisiana, to Alaska.

The modern refrigerator car is thoroughly insulated. It has double walls, doors and roof, with the space between filled with several thicknesses of building paper, or other non-conducting material. If the ice boxes are replenished frequently, the temperature should not vary more than four or five degrees between shipping point and destination. It is unimportant whether the ice boxes are at the ends or overhead. The car is iced from the outside, and the melted water is carried off without entering the car, so that the berries are kept dry as well as cool. The temperature is held around forty-five degrees. About five tons of ice are required to ice a car. Refrigerator lines operating in a commercial strawberry district must provide adequate facilities for marketing the crop. The failure of the Armour Car Line to furnish refrigerator cars in 1905 for the strawberry-growers along the Atlantic coast lines cost the company over $100,000 in damage claims.

Only sound, firm, under-ripe berries should go into a refrigerator car. Refrigeration does not improve berries; if they are soft when they go in, they will be mouldy and "leaky" when they reach market. Refrigeration merely retards the processes of ripening and decay. A refrigerator car is loaded in the same way as a ventilator car. A continuous circulation of cold, dry air passes over the berries. Before shipping, examine the drip pans to be sure they are not so choked with dirt that the melting ice will flood the car. The car is iced twelve to fifteen hours before it is loaded. In hot weather, the ice bunkers may need refilling before the car is shipped, especially if the berries are not pre-cooled. Stations for re-icing should be so placed that the car will be examined

PLATE XVIII. — *Above*, shipping shed of a coöperative association near Los Angeles, California; *below*, small schooner bringing strawberries to the Norfolk, Virginia, dock, to be shipped north by steamboat.

within twelve hours from the time it is shipped, and every twenty-four to thirty-six hours thereafter.

Water transportation.

This is confined mainly to shipping points on the South Atlantic coast, notably from the Chesapeake Bay district; also from southern Michigan to Chicago and other lake points. A considerable quantity of berries is shipped locally on various rivers. Water transportation is somewhat cheaper than rail and the berries carry better, because there is less dirt, heat and jolting. The berries are kept at a temperature of about forty-five degrees, by cakes of ice placed behind slats around the sides of the hold. The Old Dominion Line from Norfolk frequently carries 5000 sixty-quart crates a day to northern cities. Most of these are brought to the steamboat in small schooners, from strawberry fields that border estuaries many miles distant (Plate XVIII).

PRE-COOLING AND COLD STORAGE

If a car is loaded with warm berries, the temperature may rise ten to twenty degrees, and it is a day or more before all the berries are cooled to a point where decay is arrested. If possible, pick only in the cool of the morning. Set the crates in a cooling room for an hour or two after they are packed. Berries may be brought to a uniform low temperature before the car leaves the shipping point by pre-cooling.

Pre-cooling methods.

There are two methods of pre-cooling; to place the fruit in a cold room before loading, or to blow cold air

through the loaded cars. The cooling room should be heavily insulated and a temperature somewhat below freezing maintained, usually about twenty-three degrees. The refrigerator car and the cooling room are connected with a canvas hood so that the fruit does not become warm when loading. A plant costing about $1500 will cool one or two cars daily. In the cold air blast method, large fans force air over ammonia or brine refrigerating coils; then it is conducted into the car near the middle and distributed by means of deflectors and baffles. It is withdrawn from the car through the end hatches by an exhaust and then passes over the cold coils again. To pre-cool a car in four or five hours, a temperature of eight to ten degrees must be maintained. It is difficult to cool the entire load uniformly. As soon as the berries in the middle of the packages reach a temperature of thirty-five or forty degrees, which is as low as they can be held in transit, the air blast is shut off and the hatches closed. Pre-cooling is desirable when strawberries are to be shipped a long distance, but it has been used very little thus far, mainly because of the expense. The cooling-room method is practicable for large growers or small shipping associations; the chief disadvantage is that it necessitates an extra handling of the fruit. The equipment required for air-blast precooling is so expensive that it is practicable only for the largest shipping associations and for transportation companies.

Cold storage.

When berries are shipped to reach the market on Saturday they should be in refrigerator cars so that if necessary they may be carried over Sunday in the car.

In the large markets strawberries are stored for one to three days only, to prevent loss during a glut, or to carry them over Sunday or a holiday. Perhaps the most common use of storage is to hold berries that are to be canned. In 1902–3 the United States Department of Agriculture conducted experiments on the cold storage of strawberries, and reported: "In view of the difficulties involved in storing and the long season during which fresh-picked supplies can be obtained from various sections of the country, it will continue to be restricted mainly to the preservation of the fruit for a brief period when otherwise it would be lost. Strawberries handled under good commercial conditions kept from one to two weeks in good condition so far as appearance was concerned, but the flavor usually began to deteriorate after three or four days. Some of the firm-fleshed varieties, like Gandy, kept even longer than two weeks. Strawberries which have been stored for several days usually begin to break down within ten to twelve hours after removal from storage. The fruit kept best if picked when mature and fully colored, but still firm." [1]

THE STRAWBERRY SEASON

Until 1840, the strawberry season in northern cities was barely six weeks, — June and strawberries came together. The first extension of the season came with the marketing of early berries from New Jersey. Soon after, Delaware and Maryland entered the field, and by 1860 Norfolk had begun to compete. After the Civil War, swift steamers gave Charleston, South Carolina, a

[1] S. H. Fulton, Bul. 108, Bu. Plant Ind., U. S. D. A. (1907), pp. 7–23; also Rept. Md. Hort. Soc., 1904, pp. 98–102.

chance to reach northern markets. By 1885 Thomasville, Georgia, and northern Florida were shipping steadily. In the Mississippi Valley, there was a similar extension of the industry southward to supply the Chicago market, beginning with Berrien County, Michigan, and southern Illinois, thence by degrees to Tennessee, Missouri, Arkansas, Louisiana and Texas.

Influence of weather on the season.

Normally, there is a fairly well defined succession in the ripening periods of the different districts, from South to North; but this may be upset completely by the weather, as has been stated by a Florida grower:[1] "Suppose a frost comes sweeping down over the state, killing most of the bloom. Under favorable circumstances, we may look for ripe fruit about three weeks after the bloom opens. Suppose, after the frost, we have three or four weeks of warm weather. The result is that, instead of the fruit coming on at its natural time at each point, the state throws its whole crop on the market at one time, and there is a glut." J. S. Lapham, of Delaware, describes the disastrous season of 1903:[2] "Early berries, cut off in large proportion by the frosts, bloomed again. Helped on by rains, which at last came, they yielded heavily with the Gandy, our standard late berry. This semi-second crop, maturing out of its proper season, was dumped upon the dealers when there was not a thing they could do with it. The railroads, unprepared for this emergency, quickly exhausted their stock of refrigerator cars and also made late deliveries. Ventilator cars filled with this fruit were dumped upon the market and

[1] Proc. Fla. State Hort. Soc., 1897, pp. 107–11.
[2] Rept. Peninsula Hort. Soc., 1904, p. 61.

sold promptly, in some cases, for one cent a quart straight carloads."

The procession of shipping districts in the market.

In any large city, fresh strawberries can be bought any month of the year and are abundant about six months of the year. There are fewer strawberries on eastern markets in October and November than at any other time, but limited quantities come from California, and occasionally some from Mexico. A few berries from forced plants are sold to a very limited trade in November and December. The first berries from the Plant City district, Florida, appear in northern cities early in December; by Christmas the supply is adequate for the holiday trade. If not too green, they sell for seventy-five cents to one dollar a quart. During January and February Florida shipments increase steadily, mainly from the northern part of the state, and the price falls to thirty-five to fifty cents a quart. Florida growers have possession of the market until about March first, when southern Texas and Louisiana begin to send Klondikes in twenty-four pint cases. These sell for $2.50 to $3 a case; immediately Florida berries drop to twenty-five cents a quart. By the middle of March, Louisiana berries are going forward in car-lots and sell for $1.75 to $2.25 a twenty-four pint case. The first berries from southern Mississippi and Alabama are now on the market, at $3.50 to $4.50 a twenty-four quart case. By the last of March, Louisiana, Texas, central Mississippi and Alabama are shipping steadily, but Florida offerings are beginning to decline, as the berries are getting soft; they sell for ten to fifteen cents a quart, wholesale, which hardly pays for picking them. North and South Carolina and Arkansas

berries come in the first week in April, west Tennessee a few days later. Florida berries disappear from the market about the fifteenth of April. By the last week in April, Arkansas and North Carolina are shipping in refrigerator cars; Louisiana berries have begun to get soft and are not quoted. The second week in May usually closes the season for Alabama, central and southern Arkansas, Mississippi and the Carolinas; these districts still have berries to sell, but are forced to relinquish the market to the Ozark region, Kentucky, Tennessee and Virginia. The immense production of the Delaware-Maryland peninsula is on the market from the middle of May until the middle of June. Northern growers have the market until the middle or last of July. Oswego County, New York, and Nova Scotia do not close their season until about the first of August; while Steamboat Springs, Colorado, ships until September first. Southern California markets strawberries in limited quantity in eastern cities through October and November, and the everbearing varieties provide fruit in home gardens until Thanksgiving, meeting the first arrivals from Florida. Thus, we have, in fact, strawberries the year around. The strawberry rivals the apple, banana and orange, in the period that it can be obtained in the market in fresh condition.

The demand for the strawberry out of what has been considered its normal season, — that is, at times other than early spring, — seems to be increasing somewhat, but it cannot be expected that there will be a heavy demand in late summer and fall, when so many other fruits are available, or in early winter, when prices are very high. The bulk of the sales will continue to be during the months of March, April, May and June, with small quantities at other seasons.

Normal shipping seasons of the different districts.

The shipping seasons of the principal strawberry districts in the United States, as compiled by the Office of Markets, United States Department of Agriculture, are given below.[1] The list includes only those districts that ship in car-lots; the output of the great body of commercial planting in Pennsylvania, New York, Massachusetts and other northern states is handled in near-by markets in less than car-lot quantities, and is not included:

Alabama, Castleberry district, April 15 to June 1.
" York district, April 15 to June 1.
" Cullman district, April 15 to June 1.
" Thorsby district, April 20 to June 1.
Arkansas, Southwest district, April 25 to June 1.
" Judsonia district, April 25 to June 5.
" Ozark district, May 1 to June 5.
California, Los Angeles district, March 1 to December 1.
" Sacramento district, March 25 to August 15.
" Placer County district, April 1 to June 1.
" Fresno district, April 1 to August 15.
" Santa Clara and Santa Cruz districts, April 1 to December 1.
" Siskiyou district, May 20 to July 15.
Colorado, May 20 to September 1.
Connecticut, June 15 to July 1.
Delaware, May 15 to June 20.
Florida, Plant City district, December 1 to April 1.
" Stark district, February 10 to May 15.
Illinois, May 15 to June 20.
Indiana, May 25 to June 25.
Iowa, June 1 to June 20.
Kansas, May 20 to June 20.
Kentucky, May 10 to June 10.
Louisiana, March 15 to May 20.
Maryland, May 15 to June 30.
Michigan, June 1 to July 18.
Minnesota, June 20 to July 10.

[1] Bul. 237 (1915), "Strawberry Supply and Distribution in 1914," by W. A. Sherman, *et al.*

Mississippi, Gulf district, March 20 to May 15.
" Osyka district, April 1 to May 15.
" Sanford district, April 10 to May 15.
" Lauderdale district, April 15 to June 1.
" Durant district, April 20 to May 20.
Missouri, Ozark district, May 15 to June 20.
New Jersey, May 25 to June 25.
New York, June 1 to July 1.
North Carolina, April 15 to June 1.
Ohio, June 1 to June 25.
Oklahoma, May 10 to June 10.
Oregon, May 25 to July 15.
South Carolina, April 12 to May 25.
Tennessee, Chattanooga district, May 1 to June 5.
" Dyer-Sharon-Humbolt district, May 1 to June 5.
Texas, Alvin district, March 1 to May 15.
" Artesian Belt district, March 1 to May 15.
" Tyler district, April 1 to May 10.
Utah, June 5 to July 1.
Virginia, Norfolk district, May 1 to June 1.
" Albemarle district, May 1 to June 5.
" Eastern Shore district, May 5 to June 5.
Washington, May 20 to July 15.
Wisconsin, June 5 to July 15.

METHODS OF SELLING IN THE WHOLESALE MARKET

The strawberry is quickly perishable, and the strawberry market is notoriously mercurial. To distribute and sell a large quantity of strawberries at advantageous prices requires business judgment of a high order. In general, there are two methods of selling strawberries in the wholesale market, — by consignment to commission men and by sales f.o.b. loading station or destination.

Consignment.

Until quite recently, nearly all the sales were by consignment. The chief advantage is that the grower receives, or should receive, the full benefit of the market

on the day his berries arrive, whether prices are high or low. The commission man relieves the grower of all responsibility and anxiety about the sale of the berries, except the anxiety as to net returns. The grower assumes all the risk, the commission man none. The grower takes the chance of loss or damage in transit, the chance of glutted markets, the chance of dishonest commission men. He has no check on the middleman whatever; if dishonest, it is easy for him to pocket part of the proceeds, and telegraph "Berries arrived in bad condition." On the other hand, shippers sometimes fail to realize that berries which left them in good condition may be in bad condition when they reach the market, because they were not packed or handled properly. There are honest and dishonest commission men about in the proportion that there are honest and dishonest growers; the inexperienced grower should not consign berries to a middleman in a distant city without first looking up his business standing and bank references. Ship to one firm in a market, year after year. It takes time to work up a trade for a special brand of berries and a reputation for an honest pack. The shipper loses the benefit of it if he changes his selling agent frequently. It is a mistake to divide shipments among several commission men in the same market in order to see which firm will make the highest returns. This gives no information that is reliable and destroys the confidence that should exist between the shipper and his selling agent. Insist that the commission man shall make an itemized statement of sales by varieties. The usual commission on small lots is ten per cent; on large lots six to eight per cent. This is a reasonable charge for the service rendered.

Sales f.o.b. shipping point.

Recently there has been a decided increase in sales f.o.b. shipping point, especially in the Delaware-Maryland peninsula, the Ozark district and throughout the South. When he consigns, the grower pays all the bills, whether he gets a fair price for the berries or not. The railroad does not take cognizance of a low selling price, neither does the commission man, the box factory, the fertilizer dealer or the pickers. The plan of selling f.o.b. shipping point relieves the grower of the risks of transportation and marketing. He seldom receives as high returns from track sales as he gets occasionally on consignment, but the average is better and much of the worry of the business is eliminated.

This method is practicable only at large shipping points which attract buyers. The buyer may deal with the individual grower, and purchase wagon loads of berries as they arrive at the shipping point. A coöperative association may sell the berries of its members at public auction; this is a better way to secure their full market value. If the bids are satisfactory, the grower returns home with the money in his pocket; if not, he may consign them through the association. Shipping associations that have established a reputation for their pack sell most of their output in car-lots f.o.b. shipping point, on quotations to dealers in distant markets. The chief disadvantage of f.o.b. sales is the possibility that the several buyers at one shipping point may reach an understanding with each other not to pay over a certain price, regardless of the quality of the berries offered or the condition of the respective markets which the buyers represent. Alert growers will recognize when such an agreement in restraint of trade has been entered into, and

should coöperate in refusing to accept unfair prices. The advantages of f.o.b. sales far outweigh the disadvantages. Sales f.o.b. destination, with privilege of inspection, are seldom practicable with strawberries; the fruit is so perishable that if the car is rejected there is little opportunity for the shipper to handle it to advantage.

COÖPERATIVE MARKETING

Coöperation is more widely practiced and has been more successful in marketing strawberries than any other fruit except the orange. Most of the shipping associations are in the South and West; north of the Delaware-Maryland peninsula, there is little coöperative effort and less necessity for it, since most of the fruit goes to near or personal markets. Most of the early attempts at cooperation, between 1870 and 1885, failed because there was little or no effort to secure a uniform pack. Coöperative effort is not likely to succeed as long as most of the growers in a community are receiving profitable returns from sales made individually. Coöperation is born of dissatisfaction with existing conditions, and usually of dire necessity.

Types of selling associations.

There are two types of selling associations. In one, the fruit of each member is kept separate from that of all others, although several lots may be shipped in the same car; his returns depend on the quality of his fruit and pack. In the other, all the berries of the same variety and grade grown by different members are pooled and sold under the brand of the association, and the returns are pro-rated to the grower according to the number of

packages he contributed to that grade. The first type undertakes merely to get the fruit to market, not to set a price on it and sell it. This plan originated at Centralia, Illinois, about 1887, and has been used extensively in the South.

The advantages of a forwarding association, and the methods used, have been stated by F. S. Earle:[1] "The smaller growers at large shipping centers find it difficult to load in car-lots and thus secure low freight rates and prompt service. To obviate this difficulty a form of shipping association was early devised by which all or a number of shippers at any given point combine in loading cars. A loading and an unloading agent are appointed. The former receives the berries as they come from the farms, sees that they are properly loaded, makes out a manifest for each car showing the number of packages from each shipper to each consignee, and bills the car to the unloading agent. The entire load thus goes as a single shipment to one consignee, although it may contain berries from a hundred shippers, marked to one-fourth as many commission merchants in the same city. On the arrival of the car the unloading agent pays the freight and promptly unloads them, delivering the goods to the various commission houses, from whom he collects pro-rata for the freight and the loading and unloading charges. The same unloading agent usually acts for a number of shipping associations, so that his charges are reduced to the minimum." The Southern Produce Company, of Norfolk, Virginia, illustrates a slightly different type of forwarding association. This company attends to the loading, icing and routing of the berries, but the grower directs to whom they shall be consigned. The

[1] Yearbook, U. S. Dept. Agr., 1900, p. 449.

commission man takes six per cent of the sales and returns the balance to the grower, who then pays the Southern Produce Company for its services. Forwarding associations are being gradually superseded by pooling associations.

Pooling associations are examples of real coöperation, in that all the berries are sold under the association brand, and the members divide the proceeds, share and share alike, in proportion to the amount of fruit they have contributed to each pool. A pool consists of berries of one variety and one grade; all "fancy" Klondikes are in one pool and all "No. 1" Klondikes in another. The pool may be daily, weekly or seasonal, usually the latter. One or more executive officers are employed to supervise packing and loading and to sell the berries. The grower relinquishes his right to direct the disposition of his fruit when he leaves it at the shipping shed.

Essentials to success in coöperative marketing.

Shipping associations are not likely to succeed except under the following conditions:

(1) The grading and packing must be under the supervision of the association, not left to the individual members.

(2) The members must be obligated to ship all their berries, except such as are needed for home use, through the association.

(3) There must be a large quantity of berries of similar variety and grade.

(4) The association must be democratic; each member should have but one vote, regardless of the amount of stock that he owns. Unless these conditions are provided, the grade of fruit may be lowered if it is pooled. The grower realizes that the identity of his

fruit is lost in the pool, and may be tempted to cut down the cultural operations to the lowest possible point that will enable him barely to get his berries into the pool.

The most difficult feature is to secure a uniform pack. When the growers live close together, and the quantity of berries shipped is not large, it may be possible to use one or more central packing houses. This method is more expensive than packing on the farm, and good roads are essential. In most cases it is necessary to pack on the farm. The association may train a body of packers and send them to the different members; or it may supply each member with printed picking and packing rules. In either case, the brand of the association is stamped upon the crate only after it has been inspected at the car door. Rejected berries are turned back to the grower for such disposition as he may wish; some associations consign them. The wholesale market wants straight carlots of a single variety and grade. The most successful associations ship one variety almost exclusively, as the Klondike in Louisiana, the Aroma in Missouri and the Clark in Oregon. This means that the organization should be local, composed of neighbors with similar conditions of soil and climate and the same varieties. The more compact it is, the easier it will be to secure uniformity in pack and unanimity concerning the conduct of the association.

Sales methods in an association.

The utmost importance is attached to the choice of a business manager. Secure an experienced business man from elsewhere, preferably one who has been identified with the wholesale produce trade. If he is to serve the

members efficiently he will need their staunch support at all times. The association sells to the wholesale trade in car-lots, rarely to retail dealers. The cars are sold f.o.b. shipping point, f.o.b. destination with privilege of inspection, by consignment to a commission house, or by consignment to an agent of the association in a distant market, to be sold by him on arrival. The more closely the sales approach an f.o.b. shipping point basis, the better. This is especially true of the small association, which cannot afford to take the heavy risk in marketing by consignment, unless it has such a small quantity of berries that f.o.b. buyers are not attracted. The charge made by a shipping association for inspecting, loading and selling may be a flat price of five to ten cents a twenty-four quart crate or a percentage of the selling price, usually two or three per cent. The value of a coöperative association to the growers is not confined to selling the fruit. It buys fertilizer and packing material in car-lots at a considerable saving. It keeps the members posted on the best cultural practice, and acts as security for those who need cash to pay for packages or picking. It stimulates enterprise on matters of community interest, other than the berry business.

Federation of local shipping associations.

Local associations in different parts of the same district may find it advantageous to federate, in order to secure a better distribution of the crop and to prevent competition among themselves. This is illustrated by the experience of the Ozark district, from which about 1000 cars are marketed in a season of less than a month. At one time each of the 100 associations shipped independently, without knowing to what markets the other associations

were shipping on the same day.[1] The result was a very unequal distribution of the crop and very poor returns some years. Returns as low as twenty cents for a twenty-four quart crate were not uncommon. It became evident that if the Ozark berry business were to survive there must be a central organization to distribute the fruit. In 1905 the Ozark Fruit Growers' Association was formed for that purpose. How effectively this has been accomplished is shown by the net returns. In 1904, the average returns of twelve local associations was ninety cents a crate. In 1905, the first year of the federation, the average returns were $1.10; in 1906, $1.32; in 1907, $2.13; in 1908, $1.80; in 1909, $1.93; in 1910, $2.31. Each local association has a manager or secretary, and an inspector who passes upon the grade and pack, following rules prescribed by the local association. A chief inspector, who is paid by the general organization, visits the local associations frequently to acquaint the inspectors with the grade and methods of packing found desirable. The output of all the local associations is distributed by the general manager of the Ozark Fruit Growers' Association, but the pack of each local association is sold separately, as a unit, on its merits. This is necessary in order to preserve the advantages which location, soil, cultural skill and care in packing give to a group of fruit-growers. The market representatives advise the secretary or manager of each local association by letter of the condition on arrival of each car shipped by that association. Expenses are met by a commission of two per cent on sales.

[1] The Office of Markets, U. S. Dept. of Agriculture, now makes daily reports during the shipping season of the car-lot movement to different cities.

BY-PRODUCTS

A large and increasing proportion of the strawberry crop is marketed as by-products. In the past, these have been made wholly from berries that could not be sold while fresh at a profit. The market glut was the harvest time of the by-product factory. Now, many acres of strawberries are grown solely for by-products. Factories are located at most of the larger shipping points; when the market price of fresh fruit falls below a certain figure the berries are sent to the factory. Many more factories are needed to prevent the enormous waste of strawberries, especially in the South. In Florida, Louisiana, Mississippi, the Carolinas and Virginia, some seasons from fifteen to twenty-five per cent of the crop is not harvested, because the district has been crowded out of the market by points farther north.

Canning.

The principal by-products are canned berries, preserves, jams, sirups, jellies, crushed fruit and unfermented juice. There are more canned berries than any other by-product. The canning industry is especially prominent in Maryland, Ontario and on the North Pacific coast. Occasionally canners contract with growers for all the crop, but more frequently they buy most of their stock in the wholesale market during a glut, frequently for two cents or less a quart by the carload. Such berries usually are overripe and are much better for making into sirup or unfermented juice than for canning. Berries for canning should be very firm, tart, of high color, deep red clear to the center, and hold their shape and color well after cooking.

The price paid at the cannery ranges from two to six cents a quart, crates and baskets returned. "As from 9000 to 15,000 plants are grown per acre," says E. Hofer, of Oregon, "and a yield of one quart to the plant is easily maintained, it is possible to figure out from $150 to $300 an acre for strawberries at the cannery." In order to maintain a fair price for fresh berries the members of the coöperative association at Tropico, California, are required to put their berries into the cannery when the price falls below three cents a pint basket. The more hulls pulled off in picking the better, since they have to be removed anyhow; hence picking does not cost over one cent a quart. It costs one to two cents a quart to hull them at the factory.

Preserves, sirups and other by-products.

A few years ago the chief product of jam factories was "compound jam," the art in making which was to use as little fruit as possible. Much of the "pure strawberry jam" made by thrifty manufacturers contained no strawberries at all, but was made out of apple jelly, glucose, aniline dyes and clover seed. The "strawberry flavoring" of that period, used at soda fountains, contained little or no fruit; it was a chemical preparation. Recent national and state pure food laws have greatly increased the use of real strawberries for these purposes. Aside from the canned article, the largest demand is for crushed or preserved fruit and sirup, to be used at soda fountains. Most manufacturers prefer to put up fruit for this purpose at the point of production, rather than at the factory. They buy toward the close of the shipping season, when prices are low, beginning in Florida and working northward with the season. The method of

handling berries for this purpose is described by H. C. Thompson:[1]

"Wash the capped berries thoroughly in cold water, put them into tight barrels with sugar in about equal weight, load them into refrigerator cars and ship to a cold storage plant where they can be held until needed. Sometimes the berries are crushed before being put into barrels, but in most cases they are packed as nearly whole as possible." A washing machine is used to remove the sand. The berries can be held for a year or more in good condition, if a temperature of twenty-eight to thirty-two degrees is maintained. Barrels of strawberries preserved in this way are shipped from British Columbia to England, where they are made into jam and jelly.

A good vinegar can be made from strawberry juice, but it costs more than apple vinegar. There is a field for the manufacture of unfermented strawberry juice, prepared like grape juice. A process for drying strawberries in the sun has been reported. By-products increase consumption and make the business more stable.

[1] Farmers' Bulletin 664 (1915), U. S. Dept. of Agr., p. 20.

CHAPTER XI

COST OF PRODUCTION, YIELDS, PROFITS

Before undertaking any agricultural enterprise, it is well to consider the probable outcome. To do this accurately, one should know the average cost of each operation in it and the average price received for the product over a series of years. It makes little difference whether the cost of production is high or low if the selling price is commensurate; the aim should be to grow the grade of berries that the market desires, at the lowest possible cost.

FACTORS THAT INFLUENCE THE COST OF PRODUCTION

The cost of production is determined chiefly by the cultural skill, diligence and business acumen of the grower. Other factors are the type of farming and the acreage. In most strawberry districts, the crop occupies the land but a short time and rotation with other crops is desirable; this makes diversified farming necessary. The other crops provide employment for men and tools when the strawberries do not demand attention and, to this extent, reduce the cost of production.

The strawberry is most commonly associated with crops that require intensive culture, mainly vegetables and other fruits. Between 1870 and 1890 many general farmers were attracted to strawberry-growing, owing to the low prices of staple farm crops. Since 1890, the strawberry business has been mostly in the hands of horticul-

turists, those who grow fruit and truck exclusively or chiefly.

Acreage.

Some growers have the capacity to handle a hundred acres; others would fail with five acres. The strawberry responds profitably to intensive culture until the law of diminishing returns begins to operate. Intensive culture is more practicable under some conditions, extensive culture under others; but if most growers would reduce their acreage and cultivate it more intensively the yield to the acre would be larger, and the cost of production reduced. The desire for a large acreage has possessed growers from the very beginning of commercial culture. In 1880, J. R. Young, Jr., of Norfolk, Virginia, had 250 acres. Between 1885 and 1895, the rage for large fields reached its height. One man in the Ozark district had 350 acres and fields of 150 to 200 acres were not uncommon. Now the individual acreage is nearer ten than fifty, and 100-acre fields are uncommon. It is better for most growers to have but ten acres of a fifty-acre farm in strawberries, and the remainder in other crops than to have fifty acres of strawberries and be obliged to buy all the hay and grain.

The profits do not increase in proportion to the acreage, as some have supposed. Beyond a certain point, the cost of each cultural operation is greater, the difficulties of securing efficient labor are more pronounced, the problem of marketing is more involved and the yield to the acre is smaller. It is not wise to double the acreage after a year of good prices; many other growers may do likewise. The small grower, who does a large part of the work himself and superintends all of it, will make the most profit to the

acre, but his total profit may not equal that of the grower with a larger acreage, who gets lower returns to the acre. Each man should find the mean between intensive and extensive culture that will be most profitable under his conditions.

The cost of production is influenced by the probability of having a good crop each year. The strawberry is the surest in crop production of all fruits. Very rarely is there a complete failure from drought, frost or other untoward circumstance, although the yield may be reduced materially. Many districts have had no complete failure for over forty years. This makes the strawberry business a relatively safe investment, provided a satisfactory market is available. It is of special interest to the man with small capital, as it requires but little initial outlay and an income is derived in six to fourteen months, according to the location. Other factors that enter into the cost of production, such as the value of land, cost of labor and distance from market, need not be considered here.

The outlook for strawberry-growing is encouraging for the right sort of men. The market demand is increasing fully as rapidly as the acreage. Those who are worried about over-production should consider these facts:

In 1790 there were 96 men employed in raising food stuffs on the farm to 4 in the city who must have food, but can not raise it.
In 1860 there were 84 on the farm to 16 in the city.
In 1880 there were 44 on the farm to 56 in the city.
In 1900 there were 35 on the farm to 65 in the city.
In 1910 there were 30 on the farm to 70 in the city.

This does not point to over-production, but rather to an increase in the number of those who are dependent on the farmer and fruit-grower for food.

ESTIMATES OF COST OF PRODUCTION, YIELDS AND PRICES IN DIFFERENT DISTRICTS

Census statistics show that the average yield in the United States and Canada is about 1700 quarts an acre. The yield to the acre for the census year of 1909, in a number of the more important producing states and provinces, is given below:

	Quarts		Quarts
Arkansas	1122	Missouri	1676
British Columbia	1700	New Jersey	2046
California	3423	New York	2499
Delaware	1771	North Carolina	1903
Florida	1774	Ontario	1700
Illinois	1484	Oregon	1809
Louisiana	1794	Tennessee	1147
Maryland	1652	Virginia	1624
Massachusetts	2730	Washington	2340
Michigan	1766		

The high yield to the acre in California is due partly to the fact that the plants bear almost continuously for six to eight months; that of Massachusetts and New York to the larger acreage under market-garden culture. The average yield in Arkansas and Tennessee is no higher now than the average yield in 1845, soon after the beginning of the commercial culture of this fruit.

Census statistics are misleading in that they deal in averages; reports which show what individual cultivators have accomplished are of more interest to the prospective grower. Few growers realize the advantage of accurate cost-accounting in their business. Practically all of the statements that follow are estimates, not records; but they furnish a fairly reliable index to the present economic status of the industry in the different districts. All are on the basis of one acre.

Canada and northern United States.

In 1910 Robert Thompson, of Ontario, made the following estimate:

Rent of one acre	$10.00
Taxes	3.00
Management	50.00
Plowing	2.00
Harrowing	2.00
Seven thousand plants at $3 per thousand	21.00
Planting	5.00
Fertilizers	17.00
Hoeing and cultivating eight times	41.00
Winter covering	25.00
Delivery	12.00
Profits above allowance for management	28.00
	$216.00
Three hundred crates (7200 boxes) at 3 cents on the plants	$216.00

In the Kootenay district, British Columbia, it is considered that the cost of planting and caring for one acre until picking time is from $125 to $185. The total cost of producing a twenty-four pound crate is about $1.20, based on an average yield of 250 crates to the acre.

L. J. Farmer, of Oswego County, New York, gives an estimate for rather intensive culture in that section:

Plowing and harrowing, ready to set	$10.00
Plants	25.00
Setting	5.00
Hoeing six times	50.00
Cultivating 25 times	25.00
Mulching for winter	25.00
Removing mulch and spring weeding	15.00
Total cost to picking time	$155.00
Picking 5000 quarts	100.00
Total cost	$255.00
5000 quarts at 7¢ net	350.00
Net profit	$95.00

In 1893 and 1894 the New Jersey Experiment Station made a statistical survey of the strawberry industry of that state; 529 growers reported in 1893, and 934 in 1894. The range of yield was from 250 quarts to 10,752 quarts an acre; the average yield for the two years was 2700 quarts. "The average value for 1893, after deducting cost of cultivation, manuring and mulching, was $176.82, or 6.4¢ per quart, based on the average yield reported for that year (2765 quarts). The average returns for 1894 were $144.19 an acre, or 5.5¢ per quart. These figures are fairly indicative, we believe, of the cash side of the strawberry crop." In 1904, E. H. Rudderow, Moorestown, New Jersey, showed that it cost him 4⅓ cents to produce a quart of strawberries.[1] The average net price to the growers of New Jersey, Delaware, Maryland, Virginia and North Carolina now is about seven cents a quart. The business is conducted at a loss if the price falls below five cents a quart.

In 1907 Charles B. Welch of Michigan made the following estimate:

Rent of land	$ 7.00
Taxes	1.80
Plowing	2.00
Harrowing	1.00
Marking out	.15
Setting, four days	6.00
Plants and digging	1.50
Cultivating 7 times	3.00
Hoeing, cutting runners and blossoms	8.00
500 pounds fertilizer	6.00
Sowing one bushel oats and cultivating in	1.20
200 16-quart crates, at 12¢	24.00
Picking	40.00
Packing and hauling	10.00
	$111.65

[1] Rept. N. J. Hort. Soc., 1904, p. 51.

He adds, "This makes 200 crates of berries cost me 55.8 cents per crate, or $1.11 per bushel. Freight and cartage cost 20 cents per crate. If the berries sell for $2.44 a bushel, the commission is 24½ cents and the total cost of putting a bushel of berries on the market is $1.56. This gives a profit of 88 cents a bushel, or $88 an acre."

Southern states.

The cost of bringing an acre into bearing on new ground is estimated by W. H. List, of Tennessee, as follows:

Clearing ready for plow	$10.00
Plowing	2.50
Harrowing and laying off	1.50
200 pounds fertilizer	2.50
Setting plants	1.25
6000 plants at $1.40	8.40
Five plowings	4.00
Four hoeings	12.00
Cutting off bloom	.25
Final fall cleaning up	2.00
	$45.50

He says, "A yield of 100 crates, of 24 quarts each, is a fair average." Census statistics indicate that the average is about sixty crates to the acre. Tennessee and Kentucky growers estimate that it costs from $1.45 to $1.65 to produce a twenty-four quart crate of berries.

In the Ozark district of Missouri and Arkansas the cost of bringing an acre into bearing is about $50.00, as shown by the estimate of J. F. McNallie of Missouri: [1]

Rent of one acre	$ 5.00
Plowing and preparing ground	2.50
5000 plants	15.00
Setting plants	5.00
Cultivating 15 times	7.50
Hoeing 3 or 4 times	10.00
Mulch and spreading same	5.00
	$50.00

[1] Bul. 3, Mo. State Bd. of Hort. (1908), p. 11.

There is no charge for fertilizer in this estimate, since most of the strawberry-planting in the Ozark district is on new ground.

The average return to the crate in the Ozark district now is $1.50 to $1.75. It is considered not profitable to ship if the price falls to $1.00 or below; then the berries are sent to the cannery. A yield of 175 to 225 crates an acre is considered good, 150 crates fair, 75 to 100 crates poor. Yields of 300 to 400 crates are not uncommon.

One of the best records of cost-accounting with strawberries was reported by C. McNallie, of Missouri, in 1913:[1]

REPORT FOR FIRST CROP

Cost of Growing Plants

Number of acres reported on 20	
Cost of plowing ground two times; one in Sept., 1910, and again in Feb., 1911	$ 50.00
Cost of harrowing and dragging . .	16.02
40,000 plants; then used 35,000 to reset	350.00
Marking off land and planting . .	76.43
Resetting (labor)	19.16
Cost of hoeing four times	260.12
Cost of cultivating (part of bed 19 times; part 20 times, and part 21 times) .	136.50
Running weeder over 2 times; rolling 6 times	22.50
Cost of mulching material	54.87
Cost of applying mulch	63.43
Rent	80.00
Picking blossoms	8.75
Hauling rock	4.20
Sharpening tools	4.00
Cultivators, hoes, weeder, etc., assuming three years' use	27.00
Total	$1172.98

[1] Bul. 113, Mo. Exp. Sta. (1913), pp. 298–9.

Cost of Marketing Berries — Spring of 1912

Total number of acres reported on . 20		
Cost of picking per crate	$.42	
Cost of crates each	.15	
Cost of shed hands, row boss and hauling, per crate	.11	
Sheds, trays, etc., per crate	.04	
Commission or other association charges deducted from price received per crate	.10	
Total marketing cost		$1033.20

Returns from One-year-old Bed — Spring of 1912

Total number of acres reported on . 20			
Total value of berries sold, 1260 crates @ $1.26 per crate, net			$1587.60
Total income per acre . . .	$79.38		
Total picking and marketing expenses per acre		$51.66	
Total growing expenses per acre .		58.70	
Net loss per acre	$30.98		

REPORT FOR SECOND CROP

Cost of Care of Bed for Second Season

Total number of acres reported . . 20	
Cost of removing mulch and weeds (mulch disked down)	$ 5.00
Cost of team work at time of renewing	47.00
Cost of hoeing at renewing — None	
Cost of cultivating 6 times after renewing	30.00
Cost of hoeing after renewing, and number of hoeings — None	
Cost of mowing three times	17.50
Cost of mulching, if different from cost of previous years — None	
Use of tools, etc.	10.00
Rent	80.00
Total	$189.50

Cost of Marketing Berries

Number of acres reported 20		
Cost of picking per crate	$.48	
Cost of crates each	.15	
Cost of shed hands, row boss; hauling, per crate	.11	
Cost of shed, trays, etc., per crate .	.03	
Commission or other association charges deducted from price received per crate	.15	
Total		$1232.80

Returns Second Year

Number of acres reported 20		
Total value of berries sold, 1340 crates at $1.88	$2519.20	
Total income per acre	125.96	
Total picking and marketing cost per acre		$61.64
Total cultural cost per acre		9.48
		$71.12
Net profit per acre $54.84		

Florida and the Gulf states.

A few Florida strawberry-growers made large profits between 1880 and 1892. A net profit of $3000 an acre was reported from Bradford County in 1885.[1] At that time the first shipments frequently brought fabulous prices, as has been described by Stephen Powers.[2] "To take an acre of raw pine woods, clear, stump, break, ditch and plant it, will cost $125 to $140. The mulching and cultivation will bring expenses up to $175 to $200 per acre before a berry is picked. In addition, the best growers apply $1\frac{3}{4}$ or 2 tons of commercial fertilizer per acre,

[1] "Manual on Strawberry Fruit Culture," by O. W. Blacknall (1900), p. 90.

[2] Amer. Gard., XI (1890), p. 328.

costing $60 or $70. A hundred bushels per acre up to the end of the picking season is a fairly good yield. The best growers get from $350 to $700 an acre, clear of all expenses. I once had a few quarts in a bushel contributed by different growers which was sold in Boston and netted $52.80."

After the "big freeze" of 1894 and 1895, strawberries were planted in southern Florida; this competition soon reduced prices very materially. At present, a yield of 100 bushels of Klondike to the acre is considered good, but exceptional yields up to 6000 quarts are reported. The average price is eighteen to twenty-five cents a quart; the first shipments bring seventy-five cents to $1.25 a quart, for a few days. A grower at Plant City, Florida, makes the following estimate of expenses:[1]

Interest on investment in land	$20.00
Interest on investment in equipment	10.00
Depreciation in value of livestock and equipment	20.00
Cost of preparation of land	10.00
Cost of fertilizer	40.00
Plants	40.00
Setting plants	5.00
Cultivation	10.00
Picking 3000 quarts at 2½¢	75.00
Grading and packing at 1¢	30.00
One hundred crates at 15¢	15.00
3000 boxes	11.00
Hauling to station	10.00
	$296.00

The average yield in Louisiana and Mississippi is 150 to 250 twenty-four quart crates an acre. Normal returns are $1.25 to $1.40 a crate.

[1] Estimate furnished by H. C. Thompson, Bureau of Plant Industry, U. S. Dept. of Agr.

The cost of production in the lower Rio Grande district, Texas, has been estimated by the Office of Farm Management, United States Department of Agriculture:[1]

	Man Days	Horse Days
Breaking, harrowing, leveling	1½	5⅛
Ridging and preparing beds	2	4
Working on borders and ditches	2	
Setting 10,000 plants	8	
12 irrigations	6	
15 cultivations	15	15
Hand work with hoe	12	
Spraying	6	
Weed pulling	10	
Planting pop corn for summer shade	1	1
	56½	25⅛

Of the cash expenses the following is an average summary of the data available:

Picking, 2000 quarts (estimated yield per acre) at 3¢	$60.00
10,000 plants per acre at $3.50	35.00
2000 boxes	12.00
Cost of irrigation water	10.00
Interest on land, 6% of $150 per acre	9.00
Value of man labor 56½ days at 75¢	42.37
Value of mule labor 25⅛ days at $1.00	25.17
	$193.54

When the bed is carried for two or three years the cost of production is reduced to about $100.

Pacific states.

According to B. O. Longyear, yields in the Cañon City district, Colorado, range from 300 to 800 twenty-four quart

[1] Cir. 1, Tex. Exp. Sta.

crates an acre, the latter being from small tracts. Colorado growers estimate that the cost of production is about $1.15 for a twenty-four quart crate. Net returns of $250 an acre frequently are reported. In the Yakima Valley, Washington, a yield of 250 twenty-four quart crates is considered satisfactory for the first three years of the plantation, but 400 crates are expected the fourth year; after that the yield declines. Yields of 600 crates an acre are not uncommon. The net prices are from $1.50 to $1.70 a crate; there is no profit when it is less than $1.00. On Vashon Island, in western Washington, P. J. McCormick has picked 2458 quarts of Magoon from 1000 hill plants, which is at the rate of 800 crates, or 19,200 quarts, an acre. The average yield, however, is 275 to 300 crates, at a net price of about $1.60 a crate. The great shipping variety of the Hood River Valley, Oregon, — the Clark, — is a shy bearer. The average yield is 150 twenty-four quart crates, but 300 crate-yields sometimes are reported.

The yield to the acre in California is increased somewhat by the protracted bearing season, but not as much as might be supposed. In southern California, the average yield is 12,000 to 15,000 pint boxes an acre, but yields of 30,000 boxes are secured occasionally. Gross returns of $1500 an acre have been reported, but the average is about $500. The cost of production is heavy; it costs about $150 to plant an acre, since it requires 30,000 to 100,000 plants. The average cost of producing and marketing a pint box of berries is $3\frac{1}{2}$ cents and the average selling price around five cents. In the Los Angeles district, overhead charges are very heavy. The land is worth about $1000 an acre; most of it is rented to Japanese in four or five acre tracts for $20 an acre annually. Irrigation water is

$40 an acre annually. The Japanese live in rough shacks built in the middle of the strawberry fields (Plate XIX). Much of the strawberry-growing in southern California is by contract between American land owners and Japanese. The land owner furnishes land, water, crates or trays (to be returned), tools and all permanent equipment. The Japanese furnish all labor after the berries are planted, pay for one-half of the baskets and haul to the depot. The land owner does the marketing and divides the net returns equally with the Japanese every week; sometimes the Japanese receive two-thirds.

Results under market garden culture.

The estimates in the preceding paragraphs apply to field culture. Under intensive market-garden culture, the cost of production is much heavier and the possible net profits correspondingly higher. It was reported that T. C. Kevitt of New Jersey picked 27,000 quarts from an acre of Glen Mary in 1901.[1] These were hill plants spaced one foot apart each way. The possible yield and profit from an ideal acre under the so-called "Kevitt system" are given by Mr. Kevitt as follows:[2]

Cost the First Season

21,780 plants	$62.00
Plowing and fitting	1.00
Planting	10.00
Manure in spring	25.00
Manure in fall for mulching	25.00
Cultivating and cutting runners	60.00
Extra labor	10.00
	$193.00

[1] Rural New Yorker, 1902, p. 495.
[2] Catalogue of T. C. Kevitt, 1908.

Cost the Second Season

43,560 boxes	$130.00
Crates	100.00
Picking, at 2 cents per quart	870.00
Cartage and commission	440.00
Total	$1540.00
	193.00
Total cost	$1733.00

"The total income from one acre planted by my system, at 9 cents per quart, is $3645.54, leaving a net profit of $1900.54 each season for one acre." This statement would be more convincing if it were known that anybody has been able to secure more than half of this estimated yield to the acre, even under the most intensive culture. Burbidge reports, "A celebrated English strawberry grower said last year that his plants of British Queen had produced eight quarts of fruit per plant." No such yields have been secured in America. The net profit from an acre of strawberries under market-garden culture frequently runs over $1000. In 1901 Henry Jerolamen of New Jersey reported that a single acre had given a net return of $1700 and that the average return from his four acres was about $1000 an acre.[1]

It is probable that the bottom has not yet been reached in the price of strawberries on the wholesale market. Few consumers can afford to pay over eight or nine cents a quart retail, which will net the grower four or five cents a quart. In many cases it should be possible to grow good berries for one cent a quart, and pick them for one and one-fourth cents. The cost of packing and delivery to the depot averages about three-

[1] Rept. Wis. Hort. Soc., 1901, p. 153.

fourths of a cent a quart. If the net return at the shipping point is four cents, this leaves the grower one cent a quart, which gives some profit. At the present time, the average net returns from the wholesale market are about seven cents a quart.

CHAPTER XII

PROPAGATION AND RENEWAL

STRAWBERRIES are propagated mainly by runners or layers; and, to a slight extent, by division, cuttings and seeds. Probably wild strawberries once multiplied mostly by seeds, for the oldest and most widely dispersed species, *Fragaria vesca*, still multiplies mainly in that way.

LAYERS, OR RUNNERS

In *F. virginiana*, runners begin to form very early in the spring, before the mother plant blooms. In *F. chiloensis*, runners do not appear until after the plant has bloomed; most modern varieties have this habit. The runners continue to form and to take root until heavy frosts, provided the ground is not dry. Unlike seedlings, runners are true to type; they are merely divisions of the old plant.

Nursery methods.

The plants are grown commercially in propagating beds and all are dug; none is allowed to remain for fruiting. For home use, plants can be dug from fruiting beds, preferably those that have not yet borne. The propagating bed is planted and cared for in the same way as the fruiting bed, except that all the runners are allowed to set at will after the mother plants are well established. A sandy

loam, well filled with humus, is preferred to a heavy soil; the roots forage widely in light soils. A persistent drouth in late summer or early fall results in a shortage of plants. Some nurserymen have installed overhead irrigation systems to obviate this difficulty. Under normal conditions strong layer plants cost from $3 to $6 a thousand, according to the variety. In large centers of production, where a single variety is grown almost exclusively, good plants may be had for $2 a thousand. These are the prices of standard varieties; novelties may cost one dollar a dozen, or even one dollar a plant.

Home-grown plants.

The strawberry is propagated so easily that many commercial growers do not patronize nurserymen except to secure new varieties. According to W. F. Allen, "The nurserymen of the United States sell about ten per cent of the plants set in the country. Nurserymen sold last year (1912) one hundred million plants. Thus there were one billion plants set in 1913, which if set 8000 to 10,000 to the acre would plant 100,000 to 125,000 acres." [1]

The chief advantage of home-grown plants is that there need be no long delay in transplanting them, which may occur with nursery plants. On the other hand, the nurseryman ought to be able to produce better plants than the fruit-grower, because it is his business. Home propagation rarely is cheaper than buying an equal grade of plants from a nursery. Modern methods of packing bring nursery plants to the grower nearly as fresh as when dug.

[1] Proc. Amer. Pom. Soc., 1913, p. 168.

Where planting is done in August, September and October, as in Florida and the Gulf states, it is impossible to get northern plants early enough for setting. Northern plants are secured in February or March and set out two by four feet apart; by September the runners can be used for setting the fruiting bed. In southern California, growers prefer to set plants that are not more than one generation removed from the East or North. If they continue to propagate from their own plants, which bear almost continuously throughout the year, the stock soon loses vigor.

Value of runners taken from the fruiting bed.

The easiest way to secure plants is to dig them from the fruiting bed, preferably before it bears. Runners taken from a bed that has fruited once or more, and has not been carefully renewed each year, lack vigor. For spring planting, dig runners in the fall and heel them in over winter; if dug in the spring, the roots of the plants that are left to bear are disturbed and the yield reduced. The later in the spring the plants are dug, the more it injures the fruiting bed. The main objection is that the grower is tempted to dig the smaller and weaker plants and leave the best ones to bear fruit. In the South there is some danger that self-sown seedlings may be secured in this way. If any considerable number of plants are needed, it is far better to grow them in a propagating bed, separated from the fruiting bed, and to keep the blossoms cut off so as to promote early development of runners.

Ratio of runner increase in different varieties.

The number of runners that can be secured from each plant depends on the variety, soil, climate and culture.

PLATE XIX. — *Above*, shacks in large strawberry fields, southern California, occupied by the Japanese laborers who rent the land; *below*, coldframe used as a cutting bed in summer bedding.

F. E. Beatty, of Michigan, gives the following as the increase under average conditions: Michel, Beder Wood, Crescent, Warfield, Klondike and Dunlap, thirty-five runners from each plant. William Belt, Parson, Haverland, Aroma, Brandywine, Gandy, Sample, twenty to twenty-five runners from each plant. Clyde, Glen Mary, Clark, Marshall, Parker Earle, Bubach, fifteen runners from each plant. These figures include only the strong, well-rooted runners.

This increase under average conditions in commercial nurseries is small compared with the increase possible under special conditions. Plants of an expensive novelty may be set six feet apart each way on rich land, watered frequently with liquid manure, and all the runners hand-layered four to six inches apart. If the variety is a normal plant-maker each original plant will have made three hundred to five hundred strong runners by fall. Perhaps the greatest feat in strawberry propagation was by O. B. Galusha of Illinois. In the spring of 1878 he secured thirteen plants of Crescent, which had been introduced two years before, and set them in rich soil ten feet apart each way. He reported, "The plants entirely covered the ground before freezing weather. I raised 11,716 well rooted plants by actual count, the autumn being unusually favorable for their development." [1] He sold these plants for over $1000.

Digging, packing and shipping.

The best time to dig plants is when they are dormant. The winter mulch, old leaves and loose runners should be raked off first. Do not dig with a spade; this cuts off the

[1] Rept. Mich. Pom. Soc., 1882, p. 355; and Rept. Ind. Hort. Soc., 1890, p. 74.

roots. On heavy or stony soil a flat-tined spading fork can be used to advantage; on light soils, a five-tined manure fork. Some nurserymen use a digger drawn by four horses. It has a blade that slices the soil beneath the plants and loosens it, so that the plants are easily raked together by the men who follow the digger. A potato hook is used occasionally, but is likely to tear the roots. The diggers should work toward the plants, throwing the forks-full behind them. The soil should be shaken off the roots at once and the plants tied into bunches in the field, or carried to a cool place to be counted and bunched. Put them in tight woven baskets or wet burlap sacks to protect them from wind and sun; this is especially necessary in warm weather. The price paid by nurserymen for hand digging, counting and bunching is twenty-five cents for 1000 plants. Fifteen cents a thousand is paid for counting and bunching. Twenty-six plants are put in a bunch, one extra for good count. All runners and dead or diseased leaves are pulled off.

A few plants that are to be shipped by mail are prepared by removing all leaves but the smaller ones in the center. The roots are straightened out and laid on a very thin layer of damp sphagnum moss, covered with more moss, and so on, plants and moss alternating. The bundle is rolled in oiled paper, a piece of cardboard bound around it to protect the crowns, and covered with strong manila paper; but the leaves should be left exposed (Plate XX). When securely tied, this package will carry plants safely for five hundred miles.

Plants that are shipped by freight or express are packed in boxes with slats on the sides and tops. Old thirty-two quart berry crates are commonly used. The crate is lined with oiled paper and damp moss and the plants

PLATE XX. PACKING STRAWBERRY PLANTS FOR SHIPPING. — *Left*, box of 500 plants crated for shipping by freight or express; *right*, plants bunched for mailing.

packed in very tightly, alternating with layers of moss. If the order is for 250 to 500 plants, the bunches may be set upright; if for more, they are packed in double rows with the roots interlacing at the center and leaves exposed (Plate XX). A second or third double row may be placed above this, with damp moss between. To avoid heating, not more than 2500 plants should be packed in one crate. The top is covered with moss and oiled paper. If the crate is not full, add straw or excelsior until the cover can be crowded down, so that there will be no slack. Plants packed in this way may be shipped several thousand miles without injury, in cool weather. Sphagnum moss is used as a packing material, almost exclusively. Sawdust can be used, but is more likely to heat. It is well to stamp the date of shipment on the package. For long distance shipments some prefer to pack very closely and ship in air-tight boxes. Plants have been shipped successfully to France in sealed tin cans. This method is not likely to succeed unless the plants are perfectly dormant and the weather cool.

Quality in a strawberry plant.

Most growers prefer plants of medium size, with strong roots and small crowns, to very large plants, because there is less crown surface exposed for transpiration of water. Old plants always are undesirable. A considerable portion of the very cheap stock offered by unscrupulous nurserymen consists of two-year-old plants that have borne fruit, or potted plants that were not sold the previous summer. Until quite recently, plants about one year old were preferred for spring planting in the North. For many years it was the prevailing opinion that the first, second and third runners are valuable for setting in the

order named; that runners formed later than these, and especially alley plants, never should be used, even though of good size. The theory was that these plants had not developed strong fruit-buds, hence they would tend to run to vines rather than to fruit. Later evidence has shown that tip plants of fair size start off better in the spring, and have fewer fruit buds than older plants, which is an advantage. S. H. Warren of Massachusetts says, "I am not afraid to set small tip end plants, particularly of those varieties that are poor plant-makers. They will produce more runners than large, overgrown plants of the same variety which are prevented from making the most plants by the necessity for developing their fruit-buds." He refers to plants that are small because they were produced late in the season, not to older plants that are small because they have been crowded in the row. There is no evidence that propagation from late-formed runners tends to barrenness. In ordinary nursery practice the entire propagating row is dug and all the plants that are large enough are sold, regardless of their age. It is likely that the vigor of the plant, particularly the strength of the root system, is more important than the time of year when it was produced.

The so-called "pedigree strawberry plants," those that are said to have been propagated for a number of generations from the best mother plants, have not proved to be superior to ordinary well grown nursery stock. If plants are selected rigidly for a long term of years, it is possible that the character of the variety may be modified to an appreciable extent, but as commonly applied, the term is misleading.[1]

[1] This is considered at greater length in "The Strawberry in North America," Chapter V.

OTHER METHODS OF PROPAGATION

Practically all the plants used in commercial operations are field grown runners from maiden plants. In home gardens, and the more intensive types of market gardening, other methods are used to a slight extent, such as potted plants, cuttings or summer bedding, seeds and division.

Potted plants.

The runners from spring-set maiden plants may be layered into two-inch, two and one-half-inch or three-inch pots, in order to hasten the time when they may be detached for summer planting. This is practiced, for the most part, only in the North. Ordinarily layering is done in July and August. Several weeks before the plants are needed, the pots are filled with a specially prepared potting soil or rich soil from the field, and plunged to the rim beside the row of maiden plants, and not over eight inches distant from them. When one or two leaves have developed on a runner tip it is pressed lightly into the soil and held in place with a small stone or handful of soil. It may be necessary to go over the field several times, at intervals of four or five days. Discard "blind" runners, those in which the tip has been injured or has ceased to grow. In a normal season, it takes two or three weeks for the plant to fill the pot with roots; then it is detached, or the roots will turn brown and the plant will become pot-bound (Plate XXII). Pot-bound plants can be renewed by washing out the soil, cutting off the lifeless roots, and planting in fresh soil. The soil in the pot dries out quickly and the runners do not root readily in a dry season.

The potted plants are placed in a cool shady place and watered frequently; in a week or ten days they are ready

to be planted in the field. Nurserymen ship them without pots; the ball of roots is wrapped in paper and moss. The nursery price of potted plants is $2 to $4 a hundred, which is ten times the price of strong layer plants for spring planting; to this must be added heavy express charges. For home use, good results are secured by cutting rich thick sod into pieces four or five inches square and sinking these, grass side down, beside the mother plants. One runner is rooted in each sod. Old berry boxes are used, also.

Potted plants are too expensive to be practicable commercially. They are rarely used except in the gardens of northern amateurs. Potted plants are highly advertised by nurserymen and seedsmen; sometimes it is stated that "a year is saved," since the plants will "bear a full crop the following spring." This is only a half truth. A potted plant may bear as many berries as the average runner from spring-set plants; but since potted plants make few if any strong runners, the yield to the acre is very much smaller, unless the plants are set six inches apart each way in spaced rows, which is expensive. Potted plants either should be set so close as to occupy the entire ground, or set at the usual distance and vegetables grown between the rows both in the fall of the first year and the following spring. For those who need not consider expense, potted plants offer a means of securing maximum returns from a small space in the home garden. Under high culture they give fancy berries, but few of them.

Cuttings, or summer bedding.

For summer and fall planting in the North, plants grown from cuttings are much cheaper and about as satis-

factory as potted plants. The unrooted tips are cut from maiden plants; or runners may be used that have been thinned from the rows of spring-set plants. Make a cutting bed of mellow loam on a well-drained, sunny site, accessible to the hydrant. If a coldframe is placed over it, and the soil banked up on the outside, it will be easier to care for the plants (Plate XIX). Cut the runners in June or July, put them in wet burlap sacks and carry them immediately to shade. About one inch of the runner cord should be left attached to each plant. Part of the leaves should be trimmed off from the larger plants. Set the cuttings firmly in the soil, about three inches apart each way, with the node from which the roots will start just below the surface. The cutting bed is shaded with cotton cloth in sunny or windy weather and watered twice a day at first, once a day later. Remove the shade at night and on cloudy days; after the plants have begun to root, gradually remove it altogether. In about two weeks the plants should be well rooted and may be transplanted to the field where they are to fruit, after being watered thoroughly so that the soil will adhere to the roots. Varieties that make few runners, or that root with difficulty, may be propagated by cuttings to advantage.

Seeds.

Seedage is used only with the Alpines, and in breeding new varieties. Variation, induced by cultivation, as well as crossing, causes the seedlings of the common varieties to differ widely from their parents; they do not "come true." The variation in seedlings of the Alpines is not marked. The berries are picked when dead ripe, crushed, and the seeds separated by rubbing the pulp in dry sand or loam until seeds and soil are mixed; or the surface of

the berry may be pared off, and the parings placed in a stout cloth and kneaded under water to work out the pulp. Mix the seed with dry sand and sow it immediately in flats, coldframes or in the open ground. The soil should be light and rich; the seeds should be covered not over one-eighth of an inch deep. Water with a hand sprinkler. In two months the strongest seedlings may be pricked out and set in fruiting rows, about two feet by three feet. In the North, seedlings do not bear much until two years old; in the South, and especially with everbearing varieties, considerable fruit is secured in less than a year.

Division.

This consists of dividing an old plant into several pieces, or "fingers," each with roots attached, and setting these in the same way as layer plants. This may be done to best advantage in early spring. It is rarely practiced except to save the stock of a new or rare variety that is threatened with extinction. Some varieties that make few, if any, runners, as the Pan-American and the bush Alpines, are propagated by division.

AGE OF THE PLANTATION

The strawberry is a perennial plant; theoretically, it can live and bear indefinitely. As the plant grows older, the crown, or stem, gradually elongates, and new roots are formed each year below the point where they were the year previous, thus pushing the crown higher. Some of the so-called "tree strawberries" are merely very old plants with long stems. This habit of growth automatically limits the life of the plant, if left to itself. In a few years it has pushed so far out of the soil that it suc-

cumbs to winter injury or drought. If the soil is drawn around the plant each year, so as to keep the advancing stem covered, it will live and bear indefinitely. Good crops have been secured from hill plants that were over twenty years old.

Current practice in the North.

In all of Canada except western British Columbia, and in the United States as far south as Kentucky and Missouri, the commercial strawberry is grown mainly in matted or spaced rows and the plants are fruited for one year, occasionally two, rarely longer. It is more commonly grown as a biennial in those sections that have a mild climate, as New Jersey, the Delaware-Maryland peninsula and farther south, than in the North. A few northern market-gardeners who practice intensive culture and hill training fruit the plants five or six years, sometimes longer; but many hill-trained plants in the North are fruited but one year. When potted plants or strong layers are set in August or September they are plowed under after the first crop. Thus they occupy the land less than a year and approximate the semi-annual culture of the South.

In the South and West.

In Florida and the coastal plain of Georgia, Alabama, Mississippi, Louisiana and Texas, most of the beds are renewed each year, especially if they become foul with weeds. Formerly the attempt was made to carry the beds over the summer and fruit them two seasons. This was expensive and the results uncertain; it has been generally abandoned in favor of annual planting. The strawberry is more nearly a semi-annual in this part of the

South than an annual; the plants occupy the land but six to eight months, commonly from September to March. After the crop is off, part of the bed may be barred off, hoed and cultivated, not to fruit another year, but to grow plants for setting a new bed.

Between the large annual cropping belt of the North and the small annual or semi-annual cropping belt of the far South is a region in which strawberries are grown in narrow matted or spaced rows and fruited for two to seven years. It includes the states of Kentucky, Tennessee, the northern parts of Georgia, Alabama, Mississippi and Louisiana and the states of Arkansas and Missouri. Most of the plantations in this territory are fruited two or three years; in the Ozarks, they may stand five to seven years. Similar conditions prevail in Colorado, Montana, Idaho and other mountain states; there the second crop usually is heavier than that of the first or any subsequent years.

On the Pacific coast, where strawberries are grown mainly in hills or hedge-rows, seldom in matted rows, the plants are fruited three to five years. Twelve-year-old plants sometimes are reported as bearing well but are rarely as profitable as those under five years old. In the Hood River and Yakima valleys the third and fourth crops are best; after that the plants begin to decline. This diversity of practice in different parts of the continent results from the varied conditions noted in the following paragraphs.

FACTORS THAT DETERMINE THE LIFE OF A PLANTATION

The number of crops that it is advantageous to take from one setting depends on the location and its climate,

the method of culture, method of training, the variety and the comparative cost of renewing and resetting.

The location and its climate.

Large quantities of strawberries now are grown in parts of the South which once were considered wholly unsuited for this crop because of the long hot summer. Attempts to carry beds through the summer by means of shading and mulching have yielded indifferent results. It is more practicable, in most cases, to grow them only in the cooler part of the year. Plants set from August to October, according to the locality, will bear a good crop the following spring, five to seven months after they were set; then they are plowed under. Exactly opposite conditions are met in the higher altitudes of Montana and Colorado, which have a very short season. Plants set in April or May do not develop fully the first season and bear only one-fourth to one-third of a crop the following spring. Paying returns are not secured until the second season after planting, and it is found desirable to fruit the plants at least three years.

Method of culture.

When land is high in value and intensive culture is practiced, as in market-gardening and trucking, it is more profitable to secure one heavy crop of strawberries and then use the land for some other crop than to carry the plants through the summer, when there would be no income from the land. Liberal use is made of horse manure, which is full of weed seeds; this is another incentive to annual cropping. When strawberries are grown as a main crop on land of only moderate value, as in the Ozarks, it may be cheaper to fruit the bed several years. Annual renewal

is more practicable in commercial operations than in the home garden, where space is limited, especially if the plants are in hills or hedge-rows.

Method of training.

Hills or hedge-rows are fruited longer than matted or spaced rows, except where the climate forces annual or semi-annual cropping. The cost of establishing a plantation under hill training is large; usually it is cheaper to keep the plants for several years, even though weeds and pests become troublesome, than to set out a new field. In matted row or spaced row training, on the other hand, the cost of setting a new field may be small compared with the cost of renewing an old field and fighting weeds. Practically all of the very old plantations are hill plants. Experiments in England showed that the total weight of the fruit from hills increased with the age of the plant up to five years, but that the size decreased somewhat. The value of the crop for each of the five years was indicated by the ratios 34, 100, 117, 111 and 110 respectively.[1] Nearly all the evidence favors a life of three to seven years for hill plants. There is no reason why matted row plants could not produce profitable crops as long as hill plants, if renewed each year.

Variety.

Some varieties reach maturity slowly; they bear heavier crops the second or third years than the first. Gandy and Sharpless are conspicuous examples. Most of the varieties preferred for hill training are of this class. Others reach maximum production the first season; this was one of the many valuable traits of the Wilson. Varieties

[1] Rept. Woburn Exp. Farm, 1900, pp. 35–82, and 249–51.

commonly grown in matted or spaced rows bear somewhat heavier the first year than the second, unless the stand of plants is poorer or other conditions unfavorable.

Comparative cost of renewing and resetting.

If a good stand was secured and the first crop was heavy, the second is not likely to be as large. If the stand was poor the first year and there is prospect for a better stand the second year, a larger crop may be secured. If the bed is in good condition after the first crop, the second may be as good or better. One reason why some growers secure better crops the second year than the first is because the plants are less crowded; the process of renewing the rows, with plow and harrow, leaves them spaced better than they were the first season. The prevalence of weeds and the increasing danger from insect pests and diseases also should be considered.

The main point is, which is likely to be cheaper, — to set a new field at a cost of twenty-five to thirty dollars an acre, or to renew the old field. Probably the old field could be barred off and renewed for less than half that amount, but if the cost of fighting weeds is greater, or injury from insects and diseases larger, this saving may be more than offset. If the plants are fruited but one year, a crop of Irish potatoes, late cabbages, celery, millet and many other crops, including corn in the South, may be taken from the land the second season. When there is profit in extra early berries the old bed may be kept to advantage; it ripens berries a few days earlier than a new bed, provided it has not been renewed or cultivated. "There are times when we get more money out of our second-crop bed than our first," says C. E. Persels, of Illinois, "because they come in a week earlier, while our

market is good, even if we get twice the berries off the new bed." This is one way of extending the season of a single variety. The less cultivation or mulching given to the old bed, the earlier the berries will ripen. Although the yield is smaller, the cost of production is low.

RENEWAL METHODS

The methods to be followed in renewing a strawberry plantation depend chiefly on the way in which the plants are trained; also, to some extent, on the climate, nature of the soil, stand of plants and the season. They may be divided into two groups. The first includes methods of renewing the tops of the plants, as by mowing and burning; the second comprises ways of modifying the number of plants, as by plowing and harrowing.

Mowing and burning.

Mowing is practiced more than any other method. It is useful mainly in broadcast, matted row and spaced row training; occasionally in hedge-row and hill training. On the North Pacific coast, mowing is discouraged. In California, renewal is accomplished by stripping off the leaves and runners by hand; but the strippings are not burned upon the plants. In the Rocky Mountain region, the leaves are not mowed unless the leaf-roller has been serious. With these few exceptions, mowing is practiced whenever plants are fruited two or more seasons.

Mowing is done as soon as possible after the crop is harvested, preferably within a week. The longer the bed stands thereafter the more weedy it gets. In matted or spaced row training the cutter bar may be run very close to the ground, since the crowns are protected by the soil;

but in hedge-row or hill training the crowns are higher and allowance must be made for them. After the leaves and weeds have dried, they may be burned where they lie, or raked and carried off the field, or left on the field without burning. Burning destroys insects and diseases and clears the land of weeds; but it may injure the crowns, and it destroys mulch and humus-making material. Hill or hedge-row plants are more likely to be injured by burning than matted row plants, since the crowns are more exposed. The older the plantation the greater the danger, for the same reason. Wait until the mowings are thoroughly dry and preferably when there is a brisk breeze, so that the fire will sweep quickly across the field. Start the fire at several places on the windward side so the whole field will be afire as nearly as possible at the same time; a slow, creeping fire injures the plants. Back fires should be started near fences or orchards, first burning a few rows, then back-firing the whole field. Where a heavy winter mulch has been retained about the plants to protect the berries, it may be best to rake part of it into the alleys before burning, and to mix the mowings with it. Loosen the mulch with a fork or tedder; if it hugs the ground the heat and steam remain close to the plants and injure them. Unless mulch material is abundant and cheap, it is more economical to rake it off and stack it for use another year, than to burn it. When but little or no winter mulch is used it is desirable to scatter a little dry straw over the rows to facilitate burning.

It is necessary to burn when the mowings and mulch are quite dry, but there is less danger of injuring the plants if the soil is wet. If a good stand was not secured the first season, do not risk burning; the mowings and mulch should be raked into the middles and burned there, or raked

off the field with a horse rake. When strawberries are grown between rows of young fruit-trees, do not risk burning. Should a heavy rain fall immediately after mowing, and prevent burning for several days, the plants may start to grow again; if so, omit burning that year.

Burning is more popular in the North, where much mulching material is used, than in the South. Except when insects or diseases are serious, equally satisfactory results can be obtained with the plow, harrow or hoe, and the humus-making material saved for the soil.

Reducing the number of plants.

Destroying the tops of plants does not remedy the chief defect of old beds. In matted or spaced rows it is desirable, also, to reduce the number of old plants, so as to make room for the development of runners. Local climate, the plant-making ability of the variety, the stand secured the first year and the age of the plantation determine the number of old plants that should be retained. The older the bed, the fewer runners it will make. In wet seasons, the plants of free-running varieties may be cut out to approximately the same distance apart as when the field was planted; in very dry seasons it may be necessary to leave nearly all the old plants in order to be sure of a full stand.

After they are mowed, the rows are barred off, or narrowed to strips four to eight inches wide, so as to leave middles of tilled land in which the new plants may root. A light turning plow, bull tongue, double shovel, cultivator or disk harrow may be used to advantage. A disk harrow set to the desired width, with two or three of the center disks removed from each gang, is an efficient tool for this purpose when weighted heavily. Two rows are cut at a

time, each gang straddling a row. The mulch is cut into the ground, so that it is unnecessary to burn or remove it. When a plow is used, the furrows are thrown either toward the middles or directly upon the rows of plants, covering them completely with fresh soil. On light soils this is a distinct benefit, but on heavy soils there is danger of smothering the crowns. It is preferable to bar off the center and one side of each row, so as to encourage the setting of runners in land that was in cultivated middles the year before. The next year this process is reversed. This destroys the oldest and least valuable plants, insures the production of runners from the younger and more vigorous plants on the outside of the old row, and makes it possible to keep the land in better condition.

After the rows are barred off, subsequent thinning is done with the plow, harrow or hoe. Some growers plow across the rows, leaving the plants in squares which are about a foot in diameter and sixteen to twenty inches apart. Others harrow the rows lengthways or crossways two or three times to tear up the weaker plants, level the ridges left by the plow or disk, and draw fresh soil around the plants that remain. Hoes are then used to thin out the remaining plants so that they stand five to twenty-four inches apart. Only the strongest plants are left and the crowns of these are lightly covered with soil. The renewed bed now looks much like a new planting; in two or three weeks it is impossible to distinguish between the two except for the less regular alignment. Some who use matted row training the first year use hedge-row training subsequent years.

In the Ozark district a one-horse turning plow is used at right angle to the old rows, so as to leave the plants in small blocks about eight inches wide and three and a half

feet apart. The rows the second year run opposite from their direction the previous season. Changing the direction of the rows keeps the ground more level and helps to control weeds. This heroic thinning is not advisable except on soils which produce an abundance of plants. In the Hudson River district a narrow strip of the old row is covered with furrows from each side. Five or six days later the field is harrowed both ways. No plants can be seen, but in three or four weeks most of them push through. This method is cheaper and more effective than plowing away from the rows and chopping out; it kills the weeds better and a full stand is assured. It may not succeed on heavy land.

If late summer is very dry, matted rows that have been barred off and chopped out do not make a good stand. This has forced the growers in some sections, particularly in the lower Mississippi Valley, to abandon the method. The middles are stirred with the double shovel or single shovel, so as to destroy all alley plants and make room for a few new plants; and fresh soil is worked around the old plants. If the season is wet, the bed gets too thick.

The cost of renewing matted rows is from two dollars to fifteen dollars an acre. A man with a one-horse plow can bar off about three acres a day; if a disk harrow is used, six acres can be cut. Under average conditions, the cost is about five dollars an acre.

Renewing hills and hedge-rows.

In hill training the problem is not to reduce the number of plants but to readjust their position. Mowing or topping are advisable in most cases and sometimes burning; but the most important work is to set the plants deeper in the soil so as to favor the formation of new roots

above the old ones. This may be done most economically by drawing fresh soil around and over the crowns. Resetting was practiced to a slight extent years ago, but it is impracticable now. The crowns are covered one-half to one and a half inches deep; the lighter the soil, the deeper they may be covered without injury. If hill plants are set level with the surface the first year, they will be on a slight ridge after three or four years of renewal. When the rows are far enough apart to permit horse tillage this work can be done at little expense; if the plants are set ten to twenty-four inches apart, soil must be secured from the intervening paths. Hedge-rows are renewed like hills, but some prefer to cut out the mother plants after the first crop is harvested and replace them with runners taken from maiden plants of the previous season.

Carrying plants over the summer in the South.

The low stature of the strawberry plant and the fact that normally it has a dormant season, or resting period, some time during the year make it possible for the cultivator to carry it through a season of trying climate. It is best to grow the strawberry as an annual or semi-annual in Florida and the Gulf states, yet sometimes it is desirable to carry over certain plants. This is done with difficulty, on account of the long, hot summer, when the plants become practically dormant. Cultivation is discontinued, as it heats the soil at the surface. The weeds are scraped off at the surface with a hoe. A heavy mulch helps to keep the ground cool. If a thin row of corn is planted every four feet, its shade will be beneficial; rice and cowpeas also are useful for this purpose.

The Beeville, Texas, sub-experiment station reports: "On account of the fact that the second and third years

are the best for the production of strawberries, it is essential that every possible care be taken to insure the life of the plant during the summer months. Only two methods have thus far proved anything like successful. The first is to mulch the plants heavily with cotton seed hulls in spring, immediately following the harvest. The plants are practically covered. They are irrigated eight times during the summer. Under favorable conditions more than three-fourths of the plants are saved in this way. The objection to this method is the heavy expense. A mulch of straw is not as effective. In the southern Rio Grande region pop corn is planted in the bottom of furrows between rows of strawberries, which are irrigated during the summer. As the pop corn grows, the lower leaves are stripped off so that the air circulates more freely about the strawberry plants." Sugar-cane and cotton sometimes are planted between rows of strawberries for shade, but are not considered as useful for this purpose as pop-corn.

CHAPTER XIII

EVERBEARING VARIETIES, FORCING, AND OTHER SPECIAL METHODS OF CULTURE

Modern North American everbearing varieties are descendants of the Pan-American, which was found in a row of Bismarck by Samuel Cooper of Delevan, New York, in 1898. There has been keen interest in the North in this new race of strawberries, but its economic status is not yet fully determined. All varieties are more or less everbearing in the far South.

CULTURE OF EVERBEARERS

The introduction of the everbearers is so recent that comparatively little is known as to the best ways of handling them. It is probable that current methods of culture will be modified considerably when their nature and possibilities are better known.

Removing the blossoms.

The main difference between the culture of everbearing varieties and other sorts is in the management of the blossoms. The plants are set in early spring and the blossoms cut off until midsummer — until about the first of July, in the North — then they bear throughout August, September and October. If the blossoms of the single-bearing varieties are removed in the spring, no new ones appear in the North; everbearing varieties produce blossoms continuously until winter. The first blossoms ap-

pear three or four weeks after the plants are set; after that it is necessary to cut the blossoms every seven to ten days. If the blossoms are not removed during the spring months, the plants will ripen a few berries throughout the summer, but not enough to be worth while. They should be removed until midsummer, or until three weeks of the time when a crop is desired, and single-bearing varieties depended on for a spring crop. If set out in the fall, there will be a heavy spring crop and some fruit during the summer and fall.

Everbearers require higher culture than spring-bearing sorts. Rich soil and an equable supply of moisture throughout the growing season are essential; if either are lacking, the everbearing habit is weak. They do not bear much in a dry summer or fall. If the soil is not rich, fertilizer should be applied three or four times during the season. Some varieties, as the Progressive, set runners freely and bear on the young runners as soon as they are rooted; these should be trained in narrow matted rows. Varieties that make few, if any, runners, as the Superb, should be grown in hills, about one by three feet apart.

Harvesting and marketing.

The yield at one picking is small compared with a picking from single-bearing varieties. It costs three to five cents a quart to pick everbearers, or twice as much as to pick a spring-bearing variety. During July and August, everbearers need to be picked three or four times a week; in September, twice a week; in October, once a week may be sufficient, as the fruit ripens very slowly in cool weather. When the nights begin to get cold the berries are poor in color and flat in flavor, but

hold up fairly well in size. Pollination is likely to be poor in the fall, resulting in many buttons. The crop of the first season is rarely over 4000 quarts an acre, for all pickings between July and October. Everbearing varieties are not given a fruiting mulch, since it is necessary to continue tillage throughout the season in order to maintain moisture and provide favorable conditions for the rooting of runners. Hence, the berries will be sandy on some soils and must be washed in a colander, or in the device described on page 177. The berries should be dried before being packed for market. A limited quantity may be sold in most of the larger cities and towns for twenty-five to thirty-five cents a quart, which gives a fair profit.

The everbearers should be mulched with unusual care during the winter; they are more tender than common sorts, having been exhausted by recent fruit-bearing. This weakness is more than offset by the freedom from frost injury of the blossoms; they are much superior to spring-bearing sorts in this respect. Even if the blossoms are killed, another crop appears shortly after, as is the case with common varieties in the South. For this reason, everbearers are of special value where there is likely to be serious loss from late spring frosts. The second spring, — a year from the time the plants were set, — they bear a heavy crop at the same time as common varieties, but ripen over a longer season. This is one of the most valuable features of the North American race of everbearing varieties. Yields of 10,000 quarts an acre in the spring are not uncommon. Usually it is best to plow the bed under after this crop is harvested; if the spring crop is heavy, the plants do not bear well the remainder of the season.

Commercial value.

The everbearing varieties have not yet passed the stage of exploitation. Ultra-optimistic trade catalogues and journals still describe them in superlatives. From some accounts, one would infer that the ordinary single-bearing sorts soon will be obsolete. It may be granted, without debate, that the everbearers are a distinct addition to the home garden; but whether they will be profitable commercially is another question. W. B. Kille, of New Jersey, speaks appreciatively of their value for commercial culture:[1] "The yield of Superb, grown in matted rows from the spring crop, was at the rate of 11,500 quarts per acre, while Gandy and Chesapeake beside them made less than 6000 quarts per acre. All three had the same treatment. The Superb can be handled by two classes of growers. First, by the specialist who will devote all his energy to the production of fall berries exclusively. This can best be done by planting on the hill system and removing all blossoms until July 10th or 15th. Second, by the commercial grower who will train them in matted rows or restricted matted rows and who will get enough berries in the fall of the first season to pay for establishing the bed, and then rely upon the spring crop for his greatest returns. If grown in matted rows, it will produce a small crop in the fall, which will sell at about three times what the spring crop brings, and also a very large spring crop."

It is difficult to forecast the future of the everbearers at this time. We are only at the beginning of their improvement by breeding. The Pan-American was introduced only fourteen years ago, yet even during this short period breeders have produced varieties that

[1] Rept. N. J. Hort. Soc., 1913, p. 140.

are distinctly superior to it. At present, the everbearers are valued almost exclusively for the home garden, and occasionally for commercial culture in a limited way. The demand for strawberries during late summer and fall is so small, because of the abundance of other fruits at that time, that it seems unlikely that there will be sufficient incentive to grow them in large quantities; but every large town and city will take a few. It is expensive to keep the blossoms cut off, although some recent varieties are said not to require this. It is a heavy expense to pick small quantities of berries and market them over a long season, as southern California growers can testify. Moreover, the everbearers require higher culture than standard sorts and are more easily affected by drought. The present varieties are not as attractive in size, color and flavor as the spring-bearing sorts; undoubtedly these defects can be corrected by breeding. Until recently, the price of plants has been exorbitant. It is probable that the everbearers have but little commercial future, merely for supplying berries in the summer and fall. This has been the conclusion in Europe, where everbearing sorts have been grown much longer than here. The North American everbearers, however, have one saving factor that the European varieties do not possess in equal degree, — they bear a heavy crop in the spring of the second year. It is quite likely that when improved varieties of this type have appeared they will be grown commercially by a limited number of strawberry specialists, particularly those who have a near or personal market, but the everbearers will not find favor with those who grow strawberries for a distant wholesale market.

CULTURE OF THE ALPINE

Before the introduction of the Pan-American and its descendants, the Alpine strawberry was grown in North America in home gardens and in greenhouses. This is a form of the European wood strawberry, *F. vesca*. The berries of the Alpine are small, conical, soft, sweet and rather unattractive in color. The fruitstalks are elevated above the leaves. As a rule, seedlings are more vigorous and productive than runners, and the fruit is larger, but slightly inferior in quality. Young plants bear larger berries than old plants, sometimes one inch in diameter. Seed is sown in late winter or early spring, and the seedlings pricked out into flats. If seed is sown in February or March in the greenhouse or a window-box, the seedlings will bear a little fruit the following autumn, but not much until the next year. The plants are set twelve to eighteen inches apart each way, preferably in a partially shaded place. One of the best uses for the Alpine, especially the bush kind, is as an edging to beds. Keep all the runners and flowers picked off until midsummer, then let the plants bear the remainder of the season. The following year they will fruit more or less continuously throughout the growing season, if moisture conditions are equable and the soil rich; like all everbearers, they fruit irregularly and sparsely in dry weather and require high culture. If removed in the fall to hotbeds or a greenhouse, the plants will bear all winter.

The amount of fruit produced at one time is too small to make the Alpines valuable commercially. The yield is larger in the cool of autumn than during the heat of summer. After the second or third year the plants should be destroyed and new seedlings raised. The

Bush Alpines, which make no runners, are propagated by seedage, but can be multiplied easily by division. These varieties make a large stool, often with thirty to sixty crowns. As each crown is formed it begins to bear; hence there is a succession of fruit. The crowns, or fingers, may be separated at the end of a season, each with roots attached, and used to set a new bed. The common varieties are Red and White Alpine and Red and White Bush Alpine. Some of the best improved varieties are the Berger, Sutton, Janus, Quatre Saisone, Large Red, Improved White and Belle de Meaux. There is little interest in the Alpines now except among amateurs.

FALL CROPS AND DOUBLE-CROPPERS

Occasionally there are seasons when some varieties of the spring-bearing class bear a fall crop. This phenomenon usually follows a midsummer drought, which checks growth so severely as to approximate the normal winter resting period; then rains come and quicken the plants into the vigorous growth and fruitfulness of a second spring. Fall crops were especially common from Maine to Missouri in 1903; in some places as much as half a crop was gathered in October. The Cumberland Triumph was noted for producing fall crops.

In those parts of the Pacific Northwest and the mountain states where irrigation is practiced, "double-cropper" varieties are common. These are sorts that under certain conditions produce two crops a year, one in the spring, the other in the fall. Any variety that has many crowns and runners will succeed as a double-cropper in that region. Those most commonly used are: Jessie, Clyde, Excelsior, Magoon and Warfield. Double-cropping is the

result of cultural manipulation, not of an inherent everbearing tendency. It is accomplished by the simple expedient of withholding irrigation and drying out the plants in early summer, some two or three weeks after the first crop has been gathered, so that they have a resting period. After the leaves become brown they are mowed, raked off, burned, and the field is irrigated. The second crop ripens in September or October. These fall berries frequently bring better prices than spring berries, but the crop is not as large and the market for them is limited. Some growers cease irrigating before the plants have matured all of the spring crop, in order to secure a larger crop in the fall. A long season is necessary for double-cropping. A fall crop does not decrease the yield the next spring to an appreciable extent. Usually, it does not pay to take off a fall crop unless the spring crop was poor. Plants that are three years old, or over, are most useful for this purpose. It should be clearly understood that the true everbearing type is entirely distinct from the frequent occurrence of fall crops in standard varieties, induced by abnormal weather conditions or special cultural practice. The everbearers have a fixed tendency to bear continuously, independent of weather conditions.

FORCING IN GREENHOUSE BENCHES

The forcing of strawberries is not an important industry in North America, as it is in Europe. Since 1890, when field-grown berries from Florida began to appear in northern cities in considerable quantity as early as December, there has been a distinct lessening of interest in the greenhouse product. Forcing is now confined to the

PLATE XXI. FORCING. — *Above*, cheap greenhouse made of hot-bed sash, used for forcing strawberries at Hackensack, New Jersey; *below*, potted plants plunged in cinders in a coldframe.

private greenhouses of the wealthy and to a few commercial greenhouses near the larger cities. The price that it is necessary to charge for forced strawberries puts them beyond the reach of any but the affluent. There always will be a few who will pay $2.00 a pint for forced berries, even when Florida or California berries can be bought for fifty cents a quart; or who will pay $2.50 each for strawberry plants in six-inch pots, each plant bearing five to ten ripe berries, in order to set one plant before each guest at a dinner party. This market, however, is extremely limited and is confined to the largest cities.

Strawberries are forced in greenhouses, and are either planted directly in benches or grown in pots. Bench forcing is preferred by those who wish to produce a fair grade of berries cheaply; pot forcing, by those who wish to secure the highest grade of berries, regardless of expense. Pot forcing requires more care, but it is more convenient, and gives the gardener more perfect control over his plants.

The type of house commonly used for forcing berries in benches is a low, even span, made of hotbed sash (Plate XXI). It is seven to eight feet high, eight feet wide, with two side benches four or five feet high. After the Easter crop is harvested the house may be stripped of sash, which are used for coldframes and hotbeds. Plants for a crop to ripen for the Christmas trade are layered into three-inch pots that are plunged in the field beside virgin plants, and are transplanted to the greenhouse bench as soon as they have filled the pots with roots. They are set five to nine inches apart in rich compost, made of three parts light sandy loam to one of rotted manure. The roof of the greenhouse is stripped of sash until frost, and the plants are watered, syringed and sprayed like

potted plants. When frost has checked their growth somewhat, early in November, the sash are put on and firing begins. The heat is increased gradually; at ripening time it should be ninety degrees on sunny days and sixty degrees at night. Great care in watering is necessary; in dark, wet weather the entire crop may mildew if the plants are over-watered. The trusses of berries are propped off the ground with forked sticks. Plants for the second crop are not layered into pots, but strong runners are transplanted from the field to coldframes in late autumn, with a big ball of soil attached. When the first crop begins to decline, these new plants are set between the old ones, which are pulled up when the fruit is off. The second crop ripens about Easter.

FORCING IN POTS

The main essential to success is strong plants with large crowns; small plants with weak crowns give poor results. These are runners from maiden plants, which are set in the spring and treated as in ordinary field culture. Two-inch or three-inch pots, filled with rich soil, are plunged to the rim on each side of the row in June. The first and strongest runners are layered into them. It is necessary to watch the pots closely as heavy rains wash them out or cultivator teeth disturb them. By the last of July or first of August the runners will be well established in the pots and should be cut off. Wait until the roots completely fill the pots, but do not let the plants become pot-bound — checked in growth by lack of soil.

The rooted runners are taken to the potting shed and shifted into six-inch pots, in which they are to fruit. The soil is preferably turf that has been secured from an old

pasture and piled up to decay for two or three years. To this is added leaf-mould and rotted manure, making a light, rich, fibrous loam. Mix three parts of this with one part of sharp sand and add dissolved bone at the rate of one quart to three or four bushels of soil. Screen the soil through a sieve of about one-quarter inch mesh. Wet the plants before they are potted. Place an inch of potsherds or gravel in the bottom of each pot; good drainage is very essential, as the plants are watered freely during the forcing period. Set the plants so that the crown will be even with the surface. Pound the soil around the ball of roots with a potting stick; it can hardly be too firm.

Care in the coldframe.

After being potted, the plants are set in the coldframe, which is located on a sunny and well-drained site, convenient to a hydrant. Cover the ground a foot deep with coal ashes or cinders, sink the frame into these several inches and bank upon the outside (Plate XXI). Plunge the pots to their rims and as close together as possible. The ashes provide drainage, keep the pots from drying out rapidly and prevent earthworms from getting into them. Water freely until the pots are well filled with roots, then sparingly, so as to ripen the crowns. All runners should be pinched off. Spray with bordeaux occasionally to keep the foliage free from blight and mildew. By autumn the plants will have very large crowns and the pots will be densely filled with roots (Plate XXII).

As winter approaches, cover the frame with sash every night to protect the plants from the first frosts and strip it during the day, thus prolonging the growing season several weeks. Water less and less frequently; during

the last growing month, keep the pots so dry that the plants almost wilt. By the middle of November, in the North, the pots should be allowed to freeze and the plants become dormant. After the plants are frozen, mulch them lightly with straw and cover the frame with sash.

Bringing the plants into heat.

Most kinds of plants must have a check in growth, such as results from frost or drying out, before they can be forced. This is desirable with the strawberry, but not absolutely necessary. If the crop is needed for Christmas trade, part of the plants may come to fruitage without a check; but plants which have had a long period of rest and have been frozen force better and the berries are of higher quality. Some gardeners do not attempt to ripen a crop before the last of February. M. Bultel has shown that strawberry plants which are subjected to fumes of ether before they are forced come into bloom two weeks earlier than untreated plants, and bear heavier.[1] Etherization makes the plant completely dormant. These plants were treated for forty-eight hours with 400 grams of ether to each cubic meter. This method may be useful for plants that are forced without being thoroughly ripened by cold weather.

The dormant plant should be brought into heat eight to ten weeks before it is desired to have ripe berries. The length of the forcing period is determined by the temperature at which the plants are held, and weather conditions. When a continuous supply of ripe fruit is desired, fresh plants should be brought in every ten days; from fifty to eighty at a time, to secure two quarts at a

[1] Jour. de la Soc. Nat. d'Horticulture de France, April, 1912, pp. 212–17.

Strong potted runner from a 3-inch pot that was plunged in the field.

Forcing crown from a 6-inch pot, representing a good strong plant.

Unrooted runner of Pan-American variety, bearing several half-ripe berries.

A good forced plant of Glen Mary, showing the low compact habit and the piece of wire screen on which the berries rest for support.

PLATE XXII. VARIOUS MANIPULATIONS OF STRAWBERRY PLANTS.

picking. Dead and diseased leaves are stripped off, the plants sprayed with bordeaux and watered freely. The pots are set on benches, preferably six to twelve inches from the glass, so that the plants will not be drawn, and are plunged into some material that will hold moisture, such as coal ashes. Narrow shelves may be suspended from the roof by iron braces. As far as possible, the gradually rising temperature of springtime out of doors should be simulated in the forcing house. During the first week, a night temperature of thirty-five to forty degrees is maintained, with ten degrees higher in the sun. Each week it is raised four or five degrees until the plants are in bloom, when it should be sixty to sixty-five degrees. It is necessary that the plants should grow slowly during the first half of the forcing period; after they have blossomed they may be forced more rapidly. When the fruit begins to swell a temperature of seventy degrees should be maintained. Low temperature after the plants come into blossom prolongs the forcing period, increases the difficulty with pollination and gives stunted plants and small berries. Excessive heat produces weak, drawn plants, increases the danger from the red-spider and gives soft, poorly flavored berries. Syringe the foliage for red-spider every sunny day; sometimes this will be necessary even on cloudy days. During pollination, syringing must be stopped, but the walks should be kept wet.

Pollination.

There are no insects or breezes in the greenhouse to distribute the pollen, so the gardener must do it, otherwise the berries will be few and imperfect. During blossoming, water the plants sparingly and ventilate

freely. The anthers shed pollen every sunny day; a little may fall upon the pistils, but not enough to pollinate them properly. In bright weather, especially as spring approaches, some varieties pollinate well if the gardener merely brushes his arm over the plants; but usually it is necessary to hand-pollinate each blossom. This is done in the middle of the day, when the house is dry. A small camel's-hair brush is used to distribute the pollen over the pistils; the surplus pollen is collected in a spoon for use on pistillate varieties, or staminate sorts that produce little pollen. Staminate varieties differ widely in their ability to produce pollen. Marshall is one of the best in this respect and Glen Mary one of the poorest, especially the early blossoms. It is impossible to grow a satisfactory plant without a fair amount of sunshine during the blossoming period. In prolonged cloudy weather, varieties that are strongly staminate normally may produce no pollen at all.

When the berries begin to swell, stimulate the plants with liquid manure. This should be given twice a week, and gradually increased in strength until the berries begin to color; then the applications should cease, as they make the berries soft and watery. Rotted cow manure or sheep manure is preferred. Nitrate of soda, at the rate of one tablespoonful to three gallons of water, is almost equally effective. Sulfate of potash and acid phosphate, in small quantities, are used after the fruit has set and until it begins to turn color. All the blossoms are pollinated, but not all the berries are allowed to mature. Small and imperfect specimens are cut off, leaving five to ten berries on each plant, according to its vigor. If they lie upon the soil they may decay; the stems may be propped up with crotched sticks, or square pieces of wire

fly screening may be laid under the trusses (Plate XXII). Forced berries are marketed in pint or quart boxes, which are lined with cotton wool, and each berry is wrapped in a strawberry leaf. Both berries and leaves should be dry. The plants are forced but once and then are thrown away.

Forcing varieties.

A good forcing variety should be vigorous, have clean foliage, produce an abundance of pollen, have long, stiff fruit-stalks and bear large glossy, dark crimson berries of high quality. The English forcing varieties are not successful here. Among the best varieties for forcing are Marshall, Glen Mary, Nich Ohmer, Brandywine and President, especially the first two. The early blossoms of Glen Mary frequently are without stamens and must be pollinated with another variety. The President is pistillate, but is an excellent forcing variety in other respects. It is best to grow three or four varieties so as to be sure of an abundant supply of pollen.

These are the methods that professional greenhouse gardeners consider essential to success. For home use, fairly good forced strawberries may be secured simply by lifting strong plants, with a large ball of soil, from the open field in January, and bringing them into heat gradually.

GROWING FANCY AND EXHIBITION BERRIES

Strawberry exhibitions are not as common now as they were fifty years ago, but the growing of fancy and exhibition berries still is a source of pride to amateur and professional alike. Some growers have been very successful in this

special phase of strawberry-culture. Chief of these was John Knox, of Pittsburgh, who sold many hundreds of bushels of Jucunda, between 1863 and 1871, at $16 a bushel. They were packed in pint boxes, which held ten berries each, and retailed at $1 a box. The most noted grower of fancy berries in recent years was E. C. Davis, of Northampton, Massachusetts. He raised many specimens of the Margaret that were three inches in diameter and one that was $3\frac{1}{8}$ inches long and $3\frac{1}{4}$ inches in diameter. John F. Beavers, of Dayton, Ohio, was very successful; many of his specimens measured nine to twelve inches in circumference. Joseph Haywood, of Ambler, Pennsylvania, raised fancy berries for market that measured five to the quart. Henry Jerolamen, of Hilton, New Jersey, has marketed many that ran ten berries to the quart. When it is remembered that in the general market "large" strawberries run seventy-five to 100 to the quart, and "small" berries 100 to 175 to the quart, these results are no small achievement.

Methods.

Until the spring of the fruiting year the methods of raising fancy and exhibition berries do not differ materially from those practiced in market-garden culture. Usually potted plants are set in July or August on heavily manured land and kept in hills; some prefer strong layers set in August. The ground is covered four or five inches deep with rotted manure in the fall. Special care is necessary in applying and removing the winter mulch. In spring, only the coarse part of the manure is raked off, and liquid manure is applied frequently after the berries begin to swell. E. C. Davis gave his plants liquid manure every day, sometimes three times a day. One-half bushel of

hen manure is placed in a burlap sack and dropped into a barrel of water until the water is the color of weak tea; this is poured on the ground between the plants, not upon them. An ounce of saltpeter in ten quarts of water gives almost as good results. A gallon of liquid manure to the square yard may be used each day without injury.

An effort should be made to prolong the period of ripening, so as to pump more water into the berries. This is accomplished by shading the plants with muslin or lath screens. Shade must be used with discretion, or color, firmness and flavor will be sacrificed to size. Select two or three of the best berries on each truss and cut off all others; this disbudding should be done as soon as a number of perfect-shaped berries have formed. Exhibition strawberries are shipped in cotton wadding — not in cotton batting, which sticks to them. Put one berry in each compartment of an egg crate. Never touch the berries, always handle them by the stems.

Strawberries may be preserved for exhibition purposes in wide-mouthed jars with tight-fitting glass stoppers. The berries should be of good color, but not fully ripe, stems on and very firm. If they are dipped quickly into melted paraffin, this helps to keep their shape. According to W. R. Ballard, a ten per cent solution of formalin and acid potassium sulfate is a fairly satisfactory preservative, but the berries lose their color in two or three years.[1]

STRAWBERRY BARRELS

The barrel is an interesting novelty for the amateur. In 1898 J. P. Ohmer, of Dayton, Ohio, who was especially successful in barrel strawberry-culture, gave these direc-

[1] Proc. Soc. Hort. Sci., 1910, pp. 60–2.

tions: "Take any iron-bound barrel, except one that has been used for pickles, sauerkraut or vinegar. Remove all hoops but four, and bore four holes in the bottom. Then space five rows of holes, twelve to a row, around the barrel, placing the fifth row five inches from the top, and the bottom row eight inches from the bottom. The holes should be 1½ inches × 3 inches and are made by boring two holes, one above another, with a 1½ inch bit. Put about two inches of fine gravel or coarse sand in the bottom of the barrel; then fill it with soil to the bottom of the first row of holes. Use clay soil well mixed with rotted manure, and be careful that it is not too wet.

"When planting, put the plants as near the top of the holes as possible, to allow for the settling of the soil. Get in the barrel and tramp the soil solid; then loosen it with a trowel where the plants are to go. Spread the roots out well. Then put soil about half way up to the next row of holes. Now take a common drain tile 12 inches long and 3 or 4 inches in diameter; stand it on end in the center of the barrel and fill it with coarse sand. Then fill up the barrel with soil a little above the next row of holes and tramp again. Be careful not to move the tile and get dirt in it. After planting the second row, lift the tile, see that the sand settles, and fill it with sand again. Then put in soil above the next row of holes, tramp and plant that row. Repeat, until the five rows are planted. Don't fail to tramp.

"After planting the tile remains in the barrel; leave it empty, so as to take the water. Pour water in the tile for the lower rows, and on top of the barrel for the two top rows. It would be impossible to water the lower plants without the tile and the core of sand. Fill the tile about once a day and put about two quarts on the

outside. You can easily water too much. Set the barrel on bricks to keep it off the ground. As the weather begins to get cold, stop watering. Use a perfect blooming variety." When winter protection is needed, build a square wooden frame around the barrel so that there will be six inches of straw all around each side. Mr. Ohmer averaged one-half bushel of berries to the barrel; forty quarts to the barrel have been reported. A device for revolving the barrel so that it can be turned to sunlight easily may be made by setting the hub of an old buggy wheel into a log, and the other hub into the end of the barrel. Strawberries in barrels ripen ten to fourteen days earlier than those in the field.

Barrel strawberry-culture fails more frequently than it succeeds. The chief difficulties are that the soil settles and pulls out the plants; also that it dries out in winter. It is very difficult to keep the soil in all parts of the barrel moist. This method is more successful in England than in North America. The strawberry barrel is merely a novelty for the amateur; it has no commercial value.

CHAPTER XIV

INSECTS, DISEASES AND FROST

The strawberry is less liable to serious injury from insects and diseases than most other fruits. Fifty years ago, when the same plantation was fruited ten to fifteen years, damage from pests was much more pronounced than now, when most plantings are fruited but one year and practically none more than four years. Most of the difficulties enumerated below may be prevented or greatly lessened by careful selection of propagating stock, short rotations, clean tillage, keeping the borders of the field free from weeds, and other cultural methods, without resorting to the use of sprays. Spraying, as a routine feature of strawberry-culture, is practiced by comparatively few growers, chiefly in the North; but periodic outbreaks of certain pests may make it desirable to spray some seasons in almost every district. Probably over ninety-five per cent of the commercial strawberry crop is grown without any spraying whatever. Nurserymen spray more than growers, so as to secure perfectly clean stock.

SPRAYING EQUIPMENT AND MATERIALS

The common types of orchard sprayers can be adapted for strawberries. The simplest equipment for a small field is a hand pump mounted on a fifty gallon barrel or larger

PLATE XXIII. SPRAYING. — A four-row spray outfit in which the power is derived from sprocket wheels.

tank and placed on a two-wheeled cart. At the rear of the rig a hollow rod is attached, to which are fastened three to five nozzles at the correct intervals to cover as many rows. The rod is connected with the barrel by a spray hose. It is preferable to use two horses, so as to straddle the rows. For larger operations, an outfit of the same type, but deriving power from sprocket wheels, is more effective, as the spraying is done without stopping the team (Plate XXIII). Compressed air knapsack sprayers are serviceable for home gardens.

Preparation of spray materials.

Bordeaux mixture is preferred for controlling fungous diseases of the strawberry, although concentrated lime-sulfur solution, diluted at the rate of one and one-half gallons of a solution testing thirty-three degrees Beaumé to fifty gallons of water, has given good results in some places. Bordeaux is made by slaking four pounds of quicklime slowly, preferably with hot water, and diluting it to make twenty-five gallons. Dissolve three pounds of bluestone (copper sulfate) in twenty-five gallons of water. This may be done quickly with hot water, or the bluestone may be placed in a burlap sack the night before the spray is to be applied and hung in a tub of water, so that the bottom of the sack is just below the surface of the water. Always use a wooden receptacle for dissolving bluestone. When ready to spray — not before — pour the lime and the bluestone solutions together into a fifty gallon barrel at the same time; do not pour one into the other. Strain the mixture through fine wire gauze before spraying, and keep it agitated.

Arsenate of lead paste is preferred to paris green for spraying strawberries, as it sticks better to the foliage.

The usual rate of application is three or four pounds to fifty gallons of spray; in most cases it is put into the bordeaux. Paste lead should be mixed with a little water to make it liquid before it is added to the bordeaux. Powdered arsenate of lead is equally effective if used at the rate of one and a half to two pounds for each fifty gallons of spray.

It is not safe to spray a fruiting field after the blossoms open; the spray will injure the blossoms and mark the berries. Leaf-eating insects that appear between blossoming and harvesting may be controlled with fresh powdered hellebore at the rate of one ounce to two gallons.

Nurserymen located in districts that are infested with root-louse should fumigate their plants with hydro-cyanic acid gas before they are shipped.

PLANT DISEASES AND THEIR CONTROL

Leaf-spot, rust or leaf-blight (*Sphærella fragariæ*).

This is the most common and most conspicuous disease attacking the strawberry. It occurs on nearly all cultivated varieties to some extent, and on the wild strawberry, *F. virginiana*. The leaves are covered with small spots or blotches, which are reddish or purplish at first; later the center becomes ashy white, bordered with red or purple (Fig. 17). The spots are distributed irregularly; when numerous they run together, forming irregular blotches. The healthy leaf surface is so reduced that the fruit does not develop properly and few runners form. Sometimes the disease attacks the fruit-stems and cuts off the food supply of the berries so that they shrivel when half grown. In very severe attacks, the whole bed is practically ruined; by midsummer it looks as though scorched by fire. Plants in heavy, wet soil are more likely to be affected than plants on light, dry soil.

Bordeaux lessens the severity of the attack, but does not hold the disease in check altogether. Spray the fruiting bed twice before the blossoms open and again immediately after; a field of virgin

plants may be sprayed at any time. The chief reliance for freedom from leaf-blight is the selection of resistant varieties. Some sorts, as Warfield, Beder Wood, Bubach and Gandy are very susceptible; others, as Brandywine, Michel and Thompson, rarely are affected seriously. Varieties that are susceptible in one place may not be in another; much depends on air drainage and soil drainage. Set

Fig. 17. — Leaf-spot, or rust.

only healthy plants. Mowing and burning the plants after harvest helps to some extent.

There are at least two other closely related forms of leaf-blight. One of these (*Aposphæria*, sp.) is distinguished from *Sphærella* by the shape of the spot, which usually begins at the margin of the leaf and extends toward the center, in the shape of the letter V. The *Ascochyta* commonly attacks the hulls and fruit-stalks. Neither responds readily to treatment.

Powdery mildew (*Sphærotheca humuli*).

Powdery mildew curls the leaves and the white mycelium of the fungus is conspicuous on the under surface. It rarely is troublesome in the field, but may be on plants forced in the greenhouse. Bordeaux spraying for leaf-blight controls this disease, also. In the greenhouse, the plants may be dusted with flour of sulfur every ten days.

Root-rot.

Some years, especially from 1902 to 1908, the root-rot or "black root" has been serious, mainly in New York, Michigan and Massachusetts. When the berries are about half grown the plants wilt and turn yellow; the roots are decayed. Most of this trouble is due to winter injury, but a bacterial disease is associated with it in some cases. Poor culture, lack of fertility, the crowding of plants in the row, insufficient mulching and wet land are favorable for this trouble.

INJURIOUS INSECTS AND THEIR CONTROL

Weevil (*Anthonomus signatus*).

Before the flower-buds open, those that are infested droop over, wither, and in a few days most of them break off and fall to the

Fig. 18. — Work of the weevil. *a*, fruit-stalk with punctured buds; *b*, wilting buds; *c*, egg; *d*, lava; *f*, pupa, all three enlarged; *g*, flower with feeding punctures.

ground; a few hang by shreds (Fig. 18). A small white grub is feeding inside. The weevil is prevalent east of the Rocky Mountains; it is especially serious in Delaware, Maryland, Virginia and North

Carolina. Sometimes it causes a loss of fifty per cent of the crop. Early blossoms are injured chiefly, so that the shortage is mostly in early fruit, which brings the highest prices.

The adult beetles hibernate over winter and appear in the strawberry field as soon as the earliest blossom buds show. They continue to emerge in great numbers for a month. The weevil is about one-tenth of an inch long, black to reddish brown, with a large black spot on each wing cover (Fig. 19). Most of the damage is caused by the female weevil, which lays an egg in the bud, then girdles the stem below it. The lava feeds within the bud; in three or four weeks it pupates and emerges as a full grown weevil. The new generation of weevils feeds for a short time on the pollen of various kinds of flowers, including the strawberry, then disappears.

Fig. 19. — Adult weevil.

Control measures are limited mainly to prevention. Since the larva feeds mainly on pollen, the most effective measure is to grow pistillate varieties and use only enough plants of staminate sorts to pollinate them. The susceptibility of varieties is in direct ratio to the amount of pollen they produce. Staminate varieties which blossom early and profusely may be used as a trap crop and are plowed under after the weevils have congregated upon them. Many growers rely entirely upon profuse-blooming staminate varieties for protection — those that produce enough blossoms to bear good crops even though attacked by the weevil. In the home garden, covering the plants closely with muslin before they bloom will protect them. The attacks of this insect are so sporadic that most growers find it impracticable to spray. All trash and weeds in and around the field should be destroyed. Use mulch only when absolutely necessary, as the weevils hibernate beneath it.

Leaf-roller (*Ancylis comptana*).

This is a pest in the Northern states and Canada, from Colorado eastward. A greenish or brownish caterpillar, about one-half of an inch long, with a shining brown head, draws the two halves of the leaflet together with silken strands and feeds on the surface of the inclosed leaf, causing it to turn brown and die. If abundant, by the middle of June the field looks as if scorched by fire. It is the

larva of a reddish-brown moth, about three-fourths of an inch wide, which lays eggs on the under surface of the young leaves in May or June. Forty-two to fifty days elapse from egg to moth. In the North there are two broods each year; in the South, three or four broods. The insects hibernate as partly grown larvæ or as pupæ, beneath trash and mulch.

Since the larva feeds for a short time on the upper surface of the leaves before entering its shelter, arsenate of lead, applied early, is quite effective. The application must be repeated every week or ten days, as fast as new leaves are put out by the plants; one spraying does little good because the eggs are laid over a long period. Mowing and burning after the crop is harvested destroys all larvæ and pupæ in the folded leaves. Plow the old beds under immediately after harvesting.

White grub (*Lachnosterna*, several species).

White grub is the most common insect attacking the strawberry. When some of the lustiest plants in the field begin to wilt, one or more grubs will be found feeding on the large roots or in the crown. The grubs are one inch to one and one-half inches long, thick, curved, dirty white with brown heads. These are the larvæ of several species of the large brownish May beetles or June bugs. The female burrows into the soil and deposits eggs one to five inches below the surface. The grub feeds the first season on plant roots at a depth of about three inches. On the approach of winter it burrows deeper into the soil. It does most of its damage the second season. The life cycle is three years, occasionally four.

Fig. 20. — White grub. The mature insect, or May beetle, is shown at *a*.

As the beetle does not feed on the strawberry plant and the grub is deep in the ground most of the time, neither can be reached with insecticides. White grubs are most abundant in land that has been in sod for several years; hence, strawberries should not be planted on a sod fallow. It is best to precede strawberries with a hoed crop, like potatoes. If this cannot be done, plow the sod deeply

early in the fall previous to planting, so as to expose the pupating grubs to the winter.

Hogs, chickens and turkeys are efficient destroyers of grubs if allowed to follow in the furrow while plowing. When a plant is infested, there is no remedy but to dig down beside the crown and find the grub. This is not practicable commercially. Applications of kainit are not effective. Plants of a valuable novelty may be wrapped in wire fly screening when set; the roots grow through the netting, but the grub cannot get to the crown.

Root-louse (*Aphis forbesi*).

The presence of this insect is indicated by spots where all the plants have been killed, and the adjoining plants look unthrifty.

Fig. 21. — Root-louse. On left, the stem mother; center, viviparous female of late summer and fall; right, the male.

Sometimes this is mistaken for winter injury. The plants dry out, the fruit is small and fails to ripen; numerous ants around the plants are another indication. Dark green, bluish or blackish lice will be found clustered on the roots and crowns of unhealthy plants. This insect is widely distributed in the states east of the Rocky Mountains, but is most destructive in Illinois, Ohio, Delaware and Maryland. It does more damage on sandy soil than on heavy soil. The insects are very abundant for several years, then disappear for a time.

Numerous small shining black eggs about one thirty-fifth of an inch long are laid in the fall by the last generation of that year, upon the stem and midribs of the greenest leaves. In the spring they hatch into wingless females, which give birth to living young throughout the season. In twelve to fifteen days the aphids are full grown and begin to bear young. The small, brown, cornfield ants carry

young aphids from the leaves and crowns to the roots. The ants feed on the honey dew that is secreted by the aphids. They carry the aphids to new plants when infested plants die, thus spreading the pest. When the food supply becomes short, winged female forms appear which fly to neighboring fields and establish new colonies. In late autumn true males and females appear, pair, and eggs are laid to continue the species over winter.

Parasitic enemies are abundant, but do not keep the aphids in check. Secure clean plants and set them on clean land. Avoid corn or melon fields which have been infested with the corn or melon aphis; such fields contain numerous ants which aid in spreading the strawberry root-louse. If there is any doubt about the plants being clean, disinfect them before they are set. This is performed successfully only when all the eggs have hatched; neither fumigation nor dipping can kill the eggs without injuring the plant. If disinfection is delayed until the eggs have hatched, however, this makes the planting season late. Dip the plants for a few minutes in a tobacco decoction or in dilute nicotine sulfate, one part to 1000; or fumigate with hydrocyanic acid gas, using one ounce per cubic foot of space for ten minutes. Plow old beds as soon as the crop has been harvested. In the North, if the field is burned over in early spring, this destroys the eggs; in the South, the aphids winter on the roots and burning is not effective.

Crown borer (*Tyloderema fragariæ*).

In the upper Mississippi Valley, strawberry plants are attacked by a thick grub, one-quarter of an inch long, white with a brown head, which burrows in the crown. In early spring, a chestnut brown snout-beetle, one-sixth of an inch long, deposits eggs in the plant near the surface of the ground, selecting the older plants. The borer reaches maturity in July and August and is transformed into a beetle in the cavity it has made. There is one generation a year.

The beetles cannot fly, so the insect spreads very slowly. A short rotation prevents it from becoming established. If plants for new settings are dug very early in the spring, before the eggs are laid, there is no danger of spreading the pest. Plow under or burn all the plants in a field that is badly infested as soon as possible after the fruit is harvested.

Slugs (*Empria*, several species).

In April or May, numerous pale, greenish caterpillars, about three-fourths inch long with yellow or brownish heads, eat irregular holes in the foliage (Fig. 22). These are the larvæ of a small, black, four-winged saw fly, which lays eggs on the plants about two weeks before the blossoms open. When not feeding they stay on the under side of the leaf, coiled in a spiral. Short rotations and spraying with arsenate of lead before the blossoms open are the best control measures. After the fruit is set, use hellebore.

Fig. 22.— Injury from slugs.

Root worms (*Typophorus* and *Colapsis*).

These are the larvæ of several species of common leaf beetles. The adult beetles are black or reddish brown, one-eighth of an inch long. They feed on the opening strawberry leaves in May and June, riddling them. The larvæ burrow into the soil and feed on the roots of the strawberry; frequently they are mistaken for white grubs. The beetles may be killed with arsenical sprays, but a short rotation is the most practicable control measure.

Crown girdler (*Otiorhynchus ovatus*).

Occasionally strawberry plants are girdled an inch or more below the surface of the ground by grubs. These feed on the roots but rarely burrow into the crown as does the white grub. Infested plants wilt and die. There are two generations in a season. The best preventives are a short rotation and to avoid sod land.

Ground beetles (*Harpalus caliginosus* and *H. Pennsylvanicus*).

In Pennsylvania, Ohio and New York, the common black ground beetles have been known to destroy an entire strawberry crop in

two or three days. They hide beneath the mulch during the day and emerge at night. At first they feed on the seeds, later on the pulp and sometimes on the green berries. No satisfactory method of control is known, except the remote possibility of finding their breeding area and destroying it. The injury is always local and temporary.

Crown moth (*Sesia rutilans*).

On the Pacific coast, strawberries suffer from a crown borer, the larva of a moth. The caterpillar is three-fourths of an inch long, dirty white, with a brown head. Plow under the old beds promptly and practice a short rotation.

Flea beetle (*Haltica ignita*).

In all parts of the continent, particularly in Florida and the Gulf states, this insect occasionally damages the strawberry crop. It is an active, oblong, shining green or blue beetle, about one-sixth of an inch long. Tiny larvæ are seen on the underside of the leaves, which become riddled with small holes. Bordeaux, or dusting with arsenate of lead, will drive the beetles away. Burn weeds near the field, especially the evening primrose.

Tarnished plant bug (*Lygus pratensis*).

This is an inconspicuous, brownish sucking insect, about one-fifth of an inch long. It is found in all parts of the continent, and attacks many kinds of plants. It punctures the young fruits of the strawberry and they remain small and deformed. Many of the "buttons" which are attributed to frost injury are caused by this insect. Since it lives on so many wild weeds, including goldenrod, wild carrot, mullein and aster, it is difficult to control. Keep the outskirts of the field clean of weeds.

Thrips (*Euthrips tritici*).

The adult thrips are one-twentieth of an inch long, brownish yellow. They appear in early spring as soon as the buds open, and suck the sap, causing the blossoms to wither. Injury from thrips is most serious during a drouth; rains destroy them. Spraying with nicotine sulfate, one part to one thousand, controls them fairly well, especially if two pounds of soap are added to each fifty gallons.

Cutworms (several species).

These are the larvæ of night-flying moths. Cutworms do more damage to strawberries in Florida and the Gulf states than elsewhere. They are of various colors, usually dark green or blackish, and one-half inch to one inch long. During the day they stay in the soil and come out at night to feed, cutting off the plants near the ground. The injury is most serious in early spring and fall. Poisoned baits are used with some success. Mix paris green or arsenate of lead with bran and add a little sirup to make it stick together. Bran bait is effective, also, when used dry at the rate of fifty parts of bran to one of paris green. The bait is scattered among the plants.

MISCELLANEOUS PESTS

Rose bug. — If rose bugs attack strawberries after the fruit is set, spraying with arsenate of lead is unsafe. Nothing can be done except to hand pick them, gather them with a scoop net or cover the vines with netting or cheesecloth.

Ants. — If ants are in the home garden, find the hill, poke a hole in it with a crowbar and pour in half a pint of bisulfide of carbon; then cover it with a blanket. The fumes will destroy the ants.

Snails. — In Louisiana and other parts of the South snails are injurious occasionally. They are harbored by the mulch, and are serious only in wet weather. Sprinkle air slaked lime — not quicklime — around the plants. Soot is used in England.

Crickets. — In the Gulf states, black and white crickets eat small holes in the fruit, causing it to rot. They hide beneath the leaves and mulch during the day and feed at night. Poisoned bran sweetened with sirup and distributed among the rows gives some relief.

Birds. — Several kinds of birds, particularly the robin, take toll from the strawberry field. In large fields the loss is so small, compared with the good that the birds do by eating insects, that the grower should not mind it; certainly he is not justified in shooting them. In home gardens, it may be desirable to cover the plants with cheesecloth or mosquito netting, pegging it close to the ground. Some use poultry netting stretched on posts six feet high, so as to provide permanent protection.

FROST PROTECTION

The strawberry plant lies close to the ground, where the temperature is considerably lower than in the branches of fruit-trees; hence, its blossoms are more likely to be killed than those of tree fruits. On the other hand, it has a long blossoming season, especially in the South, so that rarely are all the blossoms killed. The low stature of the plant makes it comparatively easy to protect from frost.

The amount of damage depends on the time of the frost, its severity and its duration. In the North, if the early blossoms are killed, others will develop, but these are likely to be small and weak. In the South, a new crop of blossoms appears a few days after the first has been destroyed; the only loss is in delaying the season three or four weeks. Pistillate varieties, as a class, are somewhat more resistant to frost than staminate varieties. No variety is "frost proof." When a number of varieties are grown side by side, one or two may be injured less than the others; this may not be due to superior hardiness but because they were not at the most susceptible stage of development. Blossoms are injured most easily when they first expand, and during fertilization. Varieties with long fruit-stalks, which elevate the blossoms well above the foliage, are especially susceptible. A light frost merely touches the apex of the cone of pistils, causing the berries to "button." Buttoning is not due to frost altogether; the tarnished plant bug, dry weather or insufficient nourishment may result in buttons. Frost injury is confined to the pistils, which turn black. The stamens and petals are not injured; the blossom looks normal unless examined closely (Plate X).

The most practicable method of avoiding frost injury

is to select an elevated site (page 6). The principal means for securing protection for established plantations are actually to cover or screen the plants with straw, cloth or other material; to prevent rapid radiation of heat from the earth by making an artificial cloud or smudge; to warm the air; to create a draft or current of air; to apply water.

Mulches.

One of the objections to a winter or spring mulch in the North is that it increases the danger from frost. The chief reason for this is that bare soil absorbs heat during the day and radiates a portion of it at night, while a straw mulch reflects much of the heat of the sun, leaving the soil beneath it cold. Mulched plants are somewhat more succulent, also. A difference of several degrees has been noticed on a frosty night between mulched and unmulched fields. This disadvantage is slight, compared with the benefits of a winter mulch in the North.

The winter mulch may be used for frost protection in two ways. If it is left on the plants late in the spring, or until they begin to bleach, the blossoming season is retarded and the danger from frost lessened thereby (page 121). Some growers remove the winter mulch from half of the field early and leave it on the other half as late as they dare. The mulch, also, may be used to cover the plants when a frost is threatened. This method has been used more than any other since 1557, when Thomas Tusser wrote in his "Five Hundred Points of Good Husbandrie":

> "If frost do continue, take this for a law,
> The strawberries look to be covered with straw,
> Laid overly trim upon crotches and bows,
> And after uncovered as weather allows."

A heavy winter mulch is pushed from over the plants into the middles, where it is ready to be used for covering the plants when frost is imminent. One man can cover one-half to one acre before midnight. The straw can be left on the plants three or four days if the weather continues cool, but should be removed as soon as possible. Only enough straw should be used barely to cover the plants.

Throughout the South where no winter mulch is used, the fruiting mulch serves the double purpose of keeping the berries clean and affording frost protection. Weather Bureau predictions are relied on for timely warning. A few hours before sunset the entire force is put at work with hand rakes covering the plants with the pine straw mulch. When no fruiting mulch is used, two or three handfuls of pine straw are thrown over each plant.

Screens.

Lath screens are effective in home gardens. Market-gardeners use muslin hotbed sash; these will keep off a frost of ten or twelve degrees. O. W. Blacknall, of North Carolina, covered his field with the muslin cloth used for tobacco plant-beds. Small stakes were driven into the ground in straight rows as wide apart as the strip of cloth. At the top of each stake was a wire hook to hold the cloth in place. He reported:[1] "Berries under the cloth ripened about one week earlier than those outside. On April 16, 1890, the ground froze half an inch deep and frost killed every exposed blossom. Not one per cent of those under the cloth was lost." The shading of strawberries is discussed further on page 265.

[1] Rept. Mo. Hort. Soc., 1900, p. 349.

Smudging and heating.

The object of smudging is to produce a cloud of smoke which will prevent the radiation of heat from the earth; the object of heating is actually to warm the air. These methods find favor in districts where no mulch is used, especially in the Pacific Northwest. They are most effective when the area to be protected is large and the land approximately level. On hilly land the cold air settles down under the smudge cloud from higher points and pushes it upward.

Piles of dry kindling are covered with wet straw, manure, corn cobs or sawdust, and are lighted with kerosene; if coal tar is poured over the fires, the smoke is denser. The distance between piles on the outside of the field should not be less than seventy-five feet, especially on the windward side, but may be less inside the field.

In recent years, heating has largely superseded smudging. There are a number of types of patented heaters; most of these burn crude oil, but some burn coal. At least 100 heaters are required to protect an acre. The expense of this method is $20 to $50 an acre a season. It is useless to begin without a large supply of oil to replenish the heaters. In 1910 Charles Staib, of Missouri, reported:[1] "The experiments taught us that we need 125 to 150 pots per acre to protect the bloom and berries fully from a frost of 24 degrees above zero. One hundred heaters per acre raise the temperature five degrees. The cost per acre for 100 heaters, besides labor, was $20 for heaters and $15.14 for oil. The temperature went to 24 degrees outside the field. Where we used 100 heaters the yield was 245 crates per acre which sold for $551.25 gross. Where no heaters were used, the yield was 96.6

[1] Rept. Mo. St. Bd. Hort., 1910, pp. 47–9.

crates per acre, which sold for $113.32 gross; so that the net profit, after deducting the cost of crates and picking, was $258.29 per acre, and we still have heaters on hand." If a thermometer placed near the surface of the ground reads 37 degrees or less by two A.M., and no clouds or mist are rising, it is advisable to start the fires.

Light frosts may be warded off by building large fires at the lower end of the field. The hot air rises and cold air rushes in to take its place, so that a current of air sets toward the fires from all parts of the field that are higher. When air is kept in motion there is not likely to be a frost.

If the ground is wet thoroughly, either by sprinkling or by irrigation, the evening before a frost is expected the danger is lessened, since the increased amount of water vapor in the air raises the dew point. If frosted plants are sprinkled at daybreak, before the sun thaws them, they are not likely to be injured, even though they were frozen severely, since the water makes them thaw out gradually. Until recently, this was practicable only in home gardens; now the overhead system of irrigation by sprinkling provides means for doing this commercially. It is necessary that the nozzle line shall rotate every four or five minutes, so as to keep all the plants wet. It is possible that heating the water used in the sprinkling system may be found practicable.

CHAPTER XV

VARIETIES

The strawberry is burdened more heavily with indefinite and mediocre varieties than any other fruit. Over 500 varieties are grown in North America to-day. New varieties indicate that the species still is in the process of evolution and that continued improvement in the garden form may be expected. They also indicate that there is an active interest in the fruit and an enlarging market for it. Fruits that command only a limited market, as the quince and currant, have few varieties. The more new varieties the better, provided each is distinct and better than all other sorts in at least one important respect. This has not been the case with two-thirds of the varieties that have been introduced since the success of the Hovey stimulated effort in this direction. The ease with which new varieties may be grown and multiplied and the very short time that it is necessary to wait for results, as compared with tree fruits, have encouraged carelessness in breeding varieties and haste in introducing them.

DOES IT PAY TO TEST NOVELTIES?

Occasionally some one declares that the old varieties are better than the new and protests against the introduction of others. He forgets that the standard sorts

to which he clings once were novelties. All must be tested to find the few that are worthy. The rapidity with which Klondike supplanted Thompson, Excelsior and other varieties in the South shows how quickly a really meritorious sort secures recognition. It is not necessary for the individual fruit-grower to test all the novelties; this would be as foolish as not to test any. Some men fail because they cling to the old sorts long after these are outclassed by more recent introductions.

Fig. 23. — Matthew Crawford, Cuyahoga Falls, Ohio; for nearly fifty years the foremost American propagator of the strawberry and one who has urged and practiced conservatism in describing novelties.

It is recognized now that the adaptation of varieties is a local and personal problem. We no longer quarrel with our neighbor because he is of the opinion that Chesapeake is a better variety than Dunlap.

The attitude of the grower toward novelties should be one of conservatism. He should cling to the standard sorts until new ones have demonstrated their superiority, as grown on his own farm. By means of trade catalogues, horticultural society proceedings, experiment station bulletins and conferences with neighbors, he can keep posted on the newer varieties. A few of those that might be useful for his conditions should be grown in a small way. He should have a small trial plot; it costs little and may be worth much. A dozen plants of a variety are sufficient to give a fair idea of its general appearance and behavior. If it seems promising, after two years in the trial bed, a small commercial area may

be set. Always have a standard variety near it for comparison.

POINTS TO CONSIDER IN SELECTING VARIETIES

The answer to the perennial question, "What is the best variety of strawberry," constantly is becoming more involved. For many years a reply, "Grow the Wilson," would have been quite satisfactory in most cases. Now, desirable varieties are more numerous and market requirements much more diverse and exacting. The adaptation of varieties to localities, soils and purposes is so intricate and personal a problem that few growers care to advise others what to plant.

Adaptation to climate and soil.

No fruit is more fickle about its habitat than the strawberry. Each region has favorite varieties; the same sort may give radically different results on neighboring farms. Many varieties are of local adaptation only. The Longworth has been forgotten, save on the San Francisco market. The Atlantic disappeared from cultivation, except in Oswego county, New York. The Dollar was discarded everywhere, except in the Florin district, California. The Clark was of little value in the Willamette Valley, Oregon, where it originated, but found a congenial habitat in the Hood River Valley. At Selbyville, Delaware, over seventy-five per cent of the planting is Parson; at Bridgeville, twenty-five miles away, nearly all the acreage is Superior. It would be interesting to speculate why the Longworth, Wilson, Monarch, Sharpless, Jessie and other old varieties have persisted in commercial cultivation on the Pacific coast, long after they have been discarded elsewhere.

Although a number of valuable sorts are of very restricted adaptation, some succeed under many conditions of soil and climate. These cosmopolitan sorts have made possible the extension of strawberry-culture to all parts of the continent. Varieties that succeed nearly everywhere, as the Wilson, Crescent, Dunlap and Haverland, dominate the markets. Varieties that are valued only in a few sections are likely to pass from cultivation because the demand for plants is not large enough to justify nurserymen in propagating them. When considering new varieties, give preference to those that have enough stamina to thrive under widely different conditions. These are likely to acquire a reputation in the markets.

Purpose for which the fruit is grown.

Few varieties are valued equally for all purposes. Those who raise berries for home use will select varieties of a different type than the favorites of the commercial grower. First of all, they will be of high quality. It is not necessary that they be firm; the firmest varieties seldom are of high quality. If the home garden receives exceptional care, some of the more tender and less productive but high flavored English sorts may be grown. Berries of large size, rich color and high flavor are valued in a home variety more than a very heavy yield. The Margaret is a typical amateur variety; it responds magnificently to high culture in the home garden, but is not a profitable commercial sort. Varieties of different periods of ripening should be selected, so as to provide a succession throughout the normal season, and including some everbearing sorts for fall fruiting.

When strawberries are grown for a near or personal market, high quality is not as essential. Town buyers

are more attracted by size, color and freshness, than by high flavor. A succession of varieties is desirable. There is, also, a limited demand in the large cities for "fancy" berries. A few persons will pay fifty to seventy-five cents a box for these when ordinary berries sell for ten or fifteen cents. Berries for the fancy market must be very large and attractive in form and color, preferably deep red, with a glossy, almost varnished, appearance. If they are of high flavor, so much the better, but this is not as essential as very large size.

The most important characteristic of the valuable wholesale market sort is good shipping quality. A variety yielding 20,000 quarts an acre is worthless if the berries cannot be put on the market in good condition. Productiveness is next in importance, size and quality last. Most of the sorts that have captured the markets have been only fair in quality, but firm and productive; if attractive in color, so much the better. For long distance shipment, berries of medium size are preferable to those that are large — they carry better. Uniformity in size and regularity in shape are desirable, also.

Preferences of the market.

The selection of varieties is influenced somewhat by the preferences of the markets. Certain varieties have an established reputation in certain markets; it is worth while to capitalize that reputation. The San Francisco Chronicle for 1898 contained this illuminating statement: "The San Francisco market knows only two varieties — the Longworth and Sharpless — and there may or may not be in any year any considerable quantity of either on the market. All compact, red berries are known as Longworth; all coarse, light-colored berries as Sharpless."

It is more profitable to grow what the market wants than to attempt to create a demand for a new variety.

The cultivation of strawberries primarily for the canning factory is becoming an important industry in some sections, notably in Maryland, Delaware, Ontario, British Columbia and Oregon. The ideal variety for canning, according to E. Hofer, of Oregon, must have "tartness and high color, be red clear through, have solid flesh, and hold color and form after being cooked in cans. It must give an exceptionally heavy yield of medium sized berries." [1] In addition, it should be self-stemming or part readily from the shuck when picked. A new type of varieties, to be grown solely for canning, is likely to develop in the next few years.

How many varieties to grow.

As competition increases, the necessity for standardization of varieties becomes more imperative. In recent years, the number of varieties that are grown for the general market at any one shipping point has been much reduced. A car of a single variety commands the attention of buyers more than a car of several varieties. Many shipping districts now grow one variety almost exclusively; as the Aroma in the Ozark region, the Clark in the Hood River Valley, and the Klondike in Florida and the Gulf states. The very few varieties that are grown commercially in the South are in striking contrast to the large number grown in the North. This is because the markets of southern growers are distant, while those of northern growers are near. If each district grew early, midseason and late varieties, the late sorts at southern points would compete with the early sorts at

[1] Rept. Ore. State Bd. Hort., 1903, p. 241.

northern points. Furthermore, each variety ripens over a much longer period in the South than in the North. When there is a shipping association, it is especially important to grow but one or two varieties. This makes it possible to standardize the pack, so that sales may be made on a definite basis and advertising may be more effective.

When catering to a local market, a number of sorts, from extra early to very late, may be profitable; but for the general market this is not likely to pay. Between March and July many districts compete in the general market; each district is forced to grow varieties that ripen when the market is supplied least, regardless of other factors. Until about 1890, northern growers found it profitable to grow early varieties for the wholesale market. Now southern berries have driven early varieties from the North, except when grown for the local markets. Fifteen years ago the Ozark region, especially northern Arkansas, grew Thompson and Michel to advantage, but these were driven off the market by Klondikes from farther South, and this district was forced to grow a medium late variety — the Aroma. The advice of G. T. Turpin, of Missouri, is applicable generally: "You should first find the niche in the market where you can get in first. After that, determine the variety for filling this niche; then plant all of one variety."

NOTEWORTHY VARIETIES [1]

Not more than sixty of the 1800 North American varieties have attained prominence. Seventeen of the

[1] All of the 1800 varieties of North American origin are described in Technical Bulletin No. 11, Virginia Agricultural Experiment Station, by S. W. Fletcher.

most important of those now in cultivation are described below. Staminate varieties are designated by (S); pistillate varieties by (P).

Aroma (S). (*Cycloma.*) — Originated in 1889, by E. W. Cruse, Leavenworth, Kansas, seedling of Cumberland Triumph; introduced in 1892. Plant semi-spreading; leaflets large, dark green; runners moderate; blossoms open midseason to late; fruit-stems erect, moderately spreading; berry large, round-conic, bright scarlet; calyx medium, adherent; seeds fairly prominent; flesh light red, firm; core white, solid; flavor mild subacid; quality good. Medium late. The dominant variety in Arkansas, Kansas, southwest Missouri. Valued because of its uniformly large size and productiveness. It ripens before Gandy and lasts a week later.

Brandywine (S). — Originated in 1889, by E. T. Ingram, Westchester, Pennsylvania, a chance seedling supposed to be Glendale x Cumberland Triumph; introduced in 1895. Plant stocky; leaves medium green; runners moderate; fruit-stalks long, carried well above the foliage; berry large, broadly round-conic, dull, dark crimson; calyx very large, easily detached; seeds yellow, exserted, but not prominent; flesh dark salmon red, rather coarse grained, firm; core hollow; flavor brisk subacid, moderately rich; quality good. Medium late. Valued in many districts, especially in southern California. The calyx frequently turns brown after the berry is picked and injures the appearance of the fruit. A good canning variety (Plate XXIV).

Bubach (P). (*Western Union*, of some.) — Originated in 1882, by J. G. Bubach, Princeton, Illinois, one of several seedlings from hand-sown seeds of unknown parentage; introduced in 1886. Plant rather low, spreading; leaves large, dark green; runners few; fruit-stalks short, rather weak; flowers large; berry large to very large, irregular-conic, usually ribbed, waxy light crimson; calyx large, adherent; seeds large, even with the surface; flesh medium red, streaked with white, medium firm to soft, coarse grained; core solid; flavor subacid; quality fair. Midseason. Widely grown between 1890 and 1905 and still valued for home use or near-by markets. Commonly pollinated with Michel, Clyde or Aroma. When properly pollinated, Bubach is one of the heaviest

PLATE XXIV. NOTEWORTHY VARIETIES OF STRAWBERRIES. — *Above*, Brandywine, a standard sort under irrigation in southern California; *below*, Wilson, the dominant variety from 1860 until 1885, and still grown, especially in the Northwest.

yielding varieties grown and usually it carries out all its berries to a good size. Pronounced "Bubaw."

Clark (S). (*Clark's Seedling; Clark's Early; Early Idaho; Hood River.*) — Originated by Fred E. Clark in Mt. Tabor District, near Portland, Oregon, from hand-sown seeds; supposed to be a seedling of Wilson; introduced about 1880. Plant erect; runners moderate; fruit-stems long, stout, erect; berry medium, round-conic, dark crimson; seeds bright yellow, protruding; flesh dark red, very firm; core solid; flavor subacid; quality good. Midseason. Grown almost to the exclusion of other sorts in the Hood River Valley, Oregon, and valued in other parts of the Pacific Northwest; fails in the East. As grown in the Northwest it has remarkable shipping qualities. It requires more moisture than many varieties and is a light bearer. A good canning sort.

Crescent (P). (*Boynton; Park Beauty.*) — Originated in 1870 by Wm. Parmalee, New Haven, Connecticut, as a chance seedling; introduced in 1876. Plant tall, with smooth, slender leaf-stalks and small medium green leaflets; runners very numerous; fruit-stalks fairly erect, well branched; berry medium or below, round-conic, usually with a depression in the apex, bright scarlet; calyx medium, recurved, easily detached; seeds medium, even with the surface or slightly protruding; flesh light red, medium firm; core pink, solid; flavor acid; quality fair. Medium early. *Crescent Improved* does not differ materially from the type.

The Crescent has been grown more than any other variety except the Wilson. Between 1875 and 1890 it dominated all markets; in the nineties it was superseded in most places by Warfield. The most valuable points of Crescent are productiveness, even on poor land, and great vigor; it is deficient in color, firmness and quality and rusts badly. The early blossoms produce enough pollen to fertilize themselves and bear lightly without any pollinizer. If neglected, the runners soon take possession of the entire field and the berries become very small.

Dunlap (S). (*Senator Dunlap; Senator.*) — Originated in 1890 by J. R. Reasoner, Urbana, Illinois, parentage uncertain, but Cumberland Triumph, Crescent, Windsor and Sucker State were used in the crosses; introduced in 1900. Plant rather small but vigorous, semi-spreading; leaf-stalks long, slender, with dark green leaflets of medium size; runners numerous; fruit-stalks long, medium stout, usually unbranched; blossoms in midseason; berry medium

to large, round-conic, often slightly necked, glossy, bright dark crimson; calyx of medium size, reflexed, easily detached; seeds medium, slightly sunken; flesh rich dark red, medium firm, fine-grained; core red, partly hollow; flavor mild subacid; quality good. Medium early.

The most widely grown variety in the North at this time. It tends to produce too many plants, rusts considerably and the berries are variable in size; but they are attractive, of good quality and are produced freely. During the latter part of the season the berries run small, largely on account of the numerous runners; it is better to restrict these to a narrow row. The berries quickly lose their bright color on the market. Dunlap is one of the best pollinizers for pistillate sorts, as it blooms profusely from early to late. It is one of the best varieties for those who cannot give high culture, as it thrives under neglect almost as well as the Wilson and Crescent. Dunlap is not firm enough for distant markets. A good variety for canning.

Excelsior (of Hubach) (S). — Originated in 1890 by Louis Hubach, Judsonia, Arkansas, Wilson x Hoffman; introduced in 1897. Plant tall; leaflets small, dark green; runners numerous; fruit-stalks short, procumbent; flowers small; berry medium, round-conic, glossy, deep dark crimson; calyx small, adherent; seeds of medium size, depressed; flesh dark red, firm, juicy; core dark red, solid; flavor very acid; quality fair. Very early. This variety has been planted extensively in the South for northern markets. It is valued for its earliness, attractive appearance and shipping quality; also because it bears well in cold weather. It is known as one of the sourest varieties, partly because it colors long before it is ripe. The foliage often rusts badly, causing late shipments to be insipid. If the rows become thick, the berries run small. It is one of the most dependable extra early sorts.

Gandy (S). (*Gandy's Prize; First Season*, of some.) — Originated in 1885 by W. S. Gandy, Newport, New Jersey, Jersey Queen x Glendale; introduced in 1888. Plant low, spreading; leaves of medium size, medium green; runners moderate; fruit-stalks large, erect; berry large, uniform, roundish to round-conic, rich dark, dull scarlet; calyx large, easily detached; seeds numerous, slightly protruding; flesh medium red, firm, coarse-grained; core hollow; flavor brisk subacid; quality good. Very late. Gandy has been the standard late variety since 1890. In recent years it has been

displaced by Aroma in some sections. Gandy requires strong soil, preferably with a clay subsoil, and an abundant supply of moisture; on thin, dry soils it buttons. Underdrained muck swamps are known as "Gandy land." A short season of ripening — usually but three or four pickings, is characteristic of this variety. The first blossoms frequently are without pollen, so it is well to plant it with Aroma. On very strong soils, it makes a rank growth in the fall, which delays the elaboration of fruit buds. An excellent shipper.

Glen Mary (semi-S). — Originated by J. A. Ingram, East Bradford, Pennsylvania, as a chance seedling where Crescent, Downer's Prolific and Sharpless had been grown; introduced in 1896. Plant spreading; leaflets dark green; runners moderate; fruit-stalks of medium length, fairly erect; berry large, irregular round-conic, ridged and deeply pitted, dark scarlet; calyx large, moderately adherent; seeds inconspicuous, of medium size, even with the surface or protruding slightly; flesh medium red, firm, juicy; core solid; flavor mild subacid to sweet; quality good. Midseason. Popular for market and home use because of its productiveness and large, handsome berries of good quality. It has two serious defects; many of the early blossoms do not produce enough pollen, and the berries tend to have white tips. The bright color fades quickly in the market. It is commonly planted with Lovett, Dunlap or Parson to furnish pollen. Under favorable conditions it spaces its runners well and bears heavily.

Haverland (P). — Originated in 1882 by B. H. Haverland, Cincinnati, Ohio, Crescent x Sharpless; introduced in 1887. Plant large, upright; foliage abundant, light green; runners few; fruit-stalks short, too weak to hold up the fruit; berries medium to large, long-conic, sometimes necked, bright light scarlet; calyx medium, easily detached; seeds numerous, large, slightly protruding; flesh light red, medium firm; core pink, solid; flavor subacid; quality good. Midseason. Popular for home use and near markets because of its exceptional productiveness. Rather soft for distant markets and too light in color but it carries fairly well if picked early. In wet seasons the berries become quite soft. It has a long ripening season and is seldom injured seriously by frost. Dunlap, Clyde, Parson, Lovett and Beder Wood are good pollinizers for Haverland. It profits by an abundance of moisture. Haverland is one of the best sorts for family use.

Jucunda (S). (*Knox's 700.*) — The origin of the American stock of this foreign variety is in doubt. In 1866 John Saul, of Washington, D.C., said, "It originated with Messrs. Jamin and Durand, France, and was imported by me in 1858"; but the same year W. R. Prince of Flushing, New York, asserted, "The Jucunda originated with John Salter, Hammersmith, England, and was imported by me in 1859." It is probable that the latter account is correct. Plant large, upright, shallow rooted; leaf-stalks smooth, leaflets large, light green; runners moderate; fruit-stalks long; flowers large; berry large, obtuse-conic, frequently irregular and coxcombed, light crimson; flesh light red, firm; flavor sweet; quality good. Midseason to late. Since 1860, Jucunda has been a standard variety for heavy, rich soils and intensive culture; it does not succeed under other conditions. John Knox, of Pittsburg, secured remarkable results with this variety; between 1860 and 1871 he reported yields of 300 to 600 bushels an acre. Jucunda does best under hill training. The young plants grow slowly and are rather weak at first; the old plants are shallow rooted, tender, and require special care in mulching. Jucunda now is grown more commonly in the West than in the East. It is a special purpose variety.

Klondike (S). — Originated by R. L. Cloud, Independence, Louisiana, Pickerproof x Hoffman; introduced in 1901. Plant erect; leaf-stalks long, leaflets of medium size, dark green; runners moderate; fruit-stalks shorter than the foliage, fairly stout; berry medium to large, round-conic, dark crimson; calyx large, reflexed, adherent, tinged with dull red; seeds medium, scattered, depressed; flesh dark red, very firm; core red, solid; flavor acid; quality fair. Midseason to late. Klondike quickly supplanted Michel, Thompson, Excelsior and other varieties in the South; now it is grown almost exclusively in many parts of the South, especially in the Gulf states, for northern markets. It is a superb shipping variety, of good size and attractive appearance, but it is sour and its lateness is a disadvantage. It is not very resistant to drought, but is quite productive. The blossoms are protected from frost by the foliage. In Florida it is being supplanted by Missionary.

Marshall (S). (*Henry.*) — Originated in 1890, as a chance seedling by Marshall F. Ewell, Marshfield Hills, Massachusetts; introduced in 1893. Plant large, erect; leaf-stalks thick, long; leaflets large, medium green, irregularly toothed; runners moderate; fruit-stalks of medium length, stiff, usually double; berry large, round-

conic, often furrowed, dark crimson; calyx of medium size, slightly discolored, somewhat depressed, easily detached; seeds rather large, slightly protruding; flesh dark red, firm, juicy; core pink, partly hollow; flavor mild subacid; quality very good. Midseason. Marshall is a standard variety for home use, forcing or a special market. It requires high culture and a rich, heavy soil; it fails completely on poor and sandy soils. Marshall is a favorite among market-gardeners who practice hill culture and manure heavily. It is an excellent exhibition variety on account of its large size, beauty and high quality; but it is rather unproductive, tender in bloom and rusts badly. It is preëminently an amateur and special purpose variety.

Sharpless (S). (*Dawley; Ontario; Shaw.*) — Originated in 1872 by J. K. Sharpless, Catawissa, Pennsylvania, from mixed seed of Jucunda, Charles Downing, Wilson and Col. Cheney, but thought to be a seedling of Charles Downing; introduced in 1877. Plant of medium size, rather spreading; leaves medium in size and color; runners moderate; fruit-stalks long, stiff; berry large, very irregular, wedge-conic, bright scarlet; calyx medium, easily detached; seeds protruding; flesh light red, medium firm; core pink, hard, often hollow; flavor mild subacid; quality good. Midseason to late. Between 1880 and 1900 the standard combination for commercial culture was Crescent pollinated with Sharpless. Sharpless is not as productive as Crescent but the berries are much larger; few varieties produce as many large berries. The main defect of this variety is the misshapen fruit. It is rather capricious, tender in blossom, and the berries are likely to have green tips and decay before fully ripe. It succeeds better in hills than in matted rows, and requires strong soil and high culture; then it bears very large berries of good quality. Sharpless is still grown to some extent on the Pacific coast, especially in California and in British Columbia.

Warfield (P). — Originated about 1882 by C. B. Warfield, Sandoval, Illinois, a chance seedling, thought to be Crescent x Wilson; introduced in 1885. Plant erect; leaflets medium in size and color, sharp-toothed; runners very numerous; fruit-stalks long, stout; berry medium, conic, glossy dark crimson; calyx large, easily detached; seeds prominent, protruding; flesh dark red, firm, fine-grained; core red, solid; flavor acid; quality fair. Early. Between 1890 and 1900 Warfield was grown more than any other early variety; the "big four" of that period were Crescent, Bubach,

Haverland and Warfield, — all pistillate sorts. It is still valued, especially in the Mississippi Valley. Warfield is a handsome berry, an excellent shipper, a good cropper and stands frost better than most varieties; but it cannot endure hot weather and does not carry out the crop unless there is plenty of moisture. The plants must be thinned severely for best results. Warfield is commonly pollinated with Excelsior or Climax for early, and Dunlap for late. It is especially valuable for canning.

William Belt (S). — Originated about 1888 by William Belt, Mechanicsburg, Ohio; introduced in 1896. Plant rather spreading; leaflets of medium size, light green; runners numerous; fruit-stalks long, stiff; berry large, first fruits very irregular, later ones wedge-conic, bright crimson; calyx medium, easily detached; seeds medium, about even with the surface; flesh medium red, medium firm, fine-grained; core pink, partly hollow; flavor mild subacid; quality very good to best. Medium late. William Belt vies with Marshall as a dessert variety. It is widely grown for home use and for a near fancy market. It is one of the best flavored berries grown but is rather uncertain in yield and rusts badly in some sections. William Belt is of the Sharpless type, both in plant and berry, but more productive. It thrives best in moist soils and fails in sands. The runners should be restricted for best results. It is a good pollinizer for pistillate sorts.

Wilson (S). (*Wilson's Albany.*) — Originated in 1851 by James Wilson, Albany, New York from mixed seed of Hovey, Ross' Phœnix and Black Prince grown without hand crossing but open to natural cross-pollination; introduced in 1854. Plants of medium size, rather spreading; foliage large, dark green; runners moderate; fruit-stems of medium length, erect, branched; berry medium, regular round-conic, dark crimson; seeds even with the surface, rather prominent; flesh dark red, very firm; core solid; flavor acid; quality good. Medium early (Plate XXIV). Wilson is the most cosmopolitan of North American varieties. Between 1860 and 1885 it was grown more than all other varieties; it practically monopolized the market until the introduction of the Crescent. At the height of its popularity it was one of the most vigorous and productive varieties ever grown, and thrived under conditions of neglect that would have starved other sorts. It colors very early, so that it has been marketed while still unripe and very sour; when fully ripe, the quality is good. After the first two pickings, the

berries rapidly dwindle in size. The Wilson is quite susceptible to leaf-blight; this was one of the causes for its rapid decline after 1885. It is still grown considerably, especially in eastern Canada, British Columbia, Oregon and other parts of the West, where it is valued especially for canning. It is an excellent pollinizer for pistillate sorts.

LESS PROMINENT VARIETIES

Annie Hubach (S). (*Anna,* of some.) — Originated by Louis Hubach, Judsonia, Arkansas, Warfield x Thompson; introduced in 1904. Berry medium, round-conic with slight neck, light crimson; flesh pale red, firm, subacid, fair; runners numerous. Medium early.

Arizona (S). (*Arizona Everbearing; Mexican Everbearing.*) — Originated Phœnix, Arizona, chance seedling, supposedly of Jessie; introduced about 1890. Berry medium, round-conic, light scarlet; flesh light red, soft, mild subacid, good; runners few. Midseason. Widely planted in the irrigated sections of the Pacific Southwest between 1895 and 1905, especially in southern California and Arizona. Still grown to a limited extent where heat and drought resistance are important. *Improved Arizona* is a selection not differing materially from the type.

August Luther (S). (*Luther.*) — Originated 1875, by August Luther, Sedalia, Missouri; introduced 1891. Berry medium, round-conic, bright crimson; flesh light red, medium firm, subacid, good; runners moderate. Early. Valued for home use or near market.

Australian (S). (*Australian Everbearing; Australian Crimson.*) — Introduced into California in 1885 by E. J. Baldwin, who is said to have secured it from Australia; but probably is a renamed American variety. Berry medium to large, round-conic, crimson; flesh medium red, very firm, subacid, good; runners moderate. Very early. In 1893 it was the dominant variety in southern California, but is now largely superseded by Brandywine. Drought and heat resistant.

Beder Wood (S). (*Racster; Wood.*) — Originated in 1881, by Beder Wood, Moline, Illinois; introduced 1890 (as *Racster*), and in 1891 as Beder Wood. Berry medium or below, regular round-conic, scarlet; flesh light red, medium firm, brisk subacid, good; runners numerous. Early. Has been a standard commercial variety but now passing out. Soft and of poor color, but very productive.

Captain Jack (S). (*Burt.*) — Originated about 1870, by Samuel Miller, Bluffton, Missouri, chance seedling, supposedly of Wilson; introduced 1874. Berry medium, round-conic, bright scarlet; flesh light red, firm, acid, good; runners numerous. Medium early. Has been a standard variety in the Rocky Mountain states. One of the hardiest sorts.

Carrie (P). — Originated by Mark T. Thompson, Rio Vista, Virginia, seedling of Haverland; introduced about 1894. Berry large, long-conic, dark scarlet; flesh medium red, medium firm, acid, good; runners moderate. Medium late. In some places considered an improvement on its parent.

Chesapeake (S). — Originated in 1903, by Geo. W. Parks, Nanticoke Point, Maryland, chance seedling; introduced 1906. Berry large, round-conic, bright crimson; flesh medium red, very firm, mild subacid, very good; runners few. Medium late. Rapidly growing in favor as a market variety, especially in the Atlantic states.

Climax (of Graham) (S). — Originated by H. W. Graham, Tyaskin, Maryland, Bubach x Hoffman; introduced 1902. Berry medium, round-conic, obtuse, dull light crimson; flesh medium red, firm, brisk subacid, fair; runners moderate. Medium early. Has been grown considerably in the Atlantic states.

Clyde (S). (*Cycloma.*) — Originated by James Stayman, Leavenworth, Kansas, seedling of Cyclone; introduced 1890. Berry medium to large, round-conic, light scarlet; flesh medium red, medium firm, subacid, good; runners moderate. Medium early. Valued for home use or near market. Too soft for distant market. Needs a strong soil to carry out the crop.

Dollar (S). — Originated by Oscar F. Felton, Merchantsville, New Jersey; introduced about 1894. Berry large, round-conic, light crimson; flesh medium red, firm, subacid, good; runners moderate. Midseason. Has been the dominant variety in the Florin district near Sacramento, California. Shows strong everbearing tendencies, the young plants often fruiting as soon as rooted. *Dollar Jr.*, a seedling of Dollar, introduced about 1900, and *Dollar No. 2*, a selection of Dollar, are not marked departures from the type. Distinct from Gold Dollar.

Early Hathaway (S). (*Texas*). — Originated 1892 by Louis Hubach, Judsonia, Arkansas, Wilson x Hoffman; introduced 1902. Berry medium, round-conic, scarlet; flesh whitish, firm, acid, fair;

runners moderate. Medium early. Ripens a few days after Excelsior. Valued for market in many sections, especially the south central states. Has been more widely disseminated as *Texas* than as Early Hathaway.

Frances Cleveland (P). (*Mrs. Cleveland.*) — Originated in 1881, by Geo. Townsend, Gordon, Ohio, seedling of Cumberland Triumph; introduced 1885. Berry medium to large, irregular round-conic, bright scarlet; flesh light red, medium firm, good; runners numerous. Midseason. Has been planted quite extensively. Distinct from Cleveland.

Fremont Williams (S). — Originated by Louis Hubach, Judsonia, Arkansas, Gandy x Bush Cluster; introduced 1904. Berry large, round-conic, light crimson; flesh medium red, firm, subacid, good; runners moderate. As late as Gandy and preferred to that variety in some sections.

Hoffman (S). — Originated about 1884, by Mr. Hoffman, Charleston, South Carolina, chance seedling, supposed seedling of Neunan; introduced 1887. Berry medium or below, round-conic, dark crimson; flesh medium red, firm, acid, fair; runners moderate. Early. From 1890 to 1900 was the dominant variety through the Southern states. Now supplanted by Klondike. Berries are very sour until fully ripe.

Jessie (S to semi-S). — Originated 1880, by F. W. Loudon, Janesville, Wisconsin, Sharpless x Miner's Prolific; introduced 1886. Berry medium to large, round-conic to irregular wedge-shape, crimson; flesh medium red, firm, subacid, good; runners few. Midseason to late. Requires high culture. Still valued on the Pacific coast.

Joe (S). (*Joe Emerson; Emerson's Joe; Joe Johnson.*) — Originated by J. H. Black, Son & Co., Hightstown, New Jersey; a seedling of Middlefield x Chair's Favorite was crossed with Sharpless, and this with Gandy; introduced 1899. Berry large, round-conic, dark crimson; flesh medium red, firm, subacid, good; runners moderate. Late. Valued under intensive culture.

Johnson (S). (*Johnson's Early.*) — Originated in 1893, by O. A. Johnson, Manokin, Maryland, supposed Crescent x Hoffman; introduced 1898. Berry medium to large, round-conic, sometimes irregular and necked, light crimson; flesh light red, medium firm, acid, good; runners numerous. Medium early. One of the largest early varieties; valued for home use and market.

Kittie Rice (P). (*Downing's Bride; Rice; Downing's Pride.*) — Originated about 1890, by J. F. Beaver, Dayton, Ohio; introduced 1896. Berry large, round-conic, dark crimson; flesh medium red, firm, brisk subacid, very good; runners moderate. Midseason. Valued for market and home use.

Late Stevens (S to semi-S). (*Stevens' Late Champion.*) — Originated in 1897, by Arthur Stevens, Bridgeton, New Jersey, said to be "Bayview" (evidently not introduced) x Cumberland Pride; introduced 1903. Berry large, irregular wedge-conic to coxcombed, light crimson; flesh medium red, medium firm, subacid, good; runners moderate. Late. A close competitor of Gandy in a few places.

Longworth (S). (*Longworth's Prolific; Schneike's Seedling; Schneike's Hermaphrodite.*) — Originated 1848, by Mr. Schneike, gardener to Nicholas Longworth, Cincinnati, Ohio, being one of "thousands of seedlings from the Hovey, Keens' and Taylor's seedlings impregnated by Swainstone seedling" (the latter an English variety); introduced 1851. Berry large, roundish-oval to roundish-flattened, light crimson; flesh medium red, firm, brisk subacid, good; runners moderate. Medium early. The oldest North American variety now in cultivation. Still a standard sort in California.

Lovett (S). (*Lovett's Early.*) — Originated in 1885, by J. H. Morris, Fairview, Kentucky, chance seedling, supposed Crescent x Wilson; introduced 1890. Berry medium to large, round-conic, bright crimson; flesh medium red, firm, acid, good; runners few. Medium early to midseason. Has been a standard variety; used largely as a pollinizer.

Magoon (S). — Originated by W. J. Magoon, Portland, Oregon, chance seedling; introduced 1894. Berry medium to large, irregular round-conic, dark crimson; flesh dark red, medium firm, mild subacid, very good; runners moderate. Midseason to late. The leading variety for home use and near market in western Oregon. Too soft for long shipment, and only fair for canning. Makes immense stools. Fruit-stems weak. Needs deep, moist soil.

Margaret (of Beaver) (S). (*Marguerite,* of some.) — Originated 1891, by J. F. Beaver, Dayton, Ohio, seedling of Crawford; introduced 1896. Berry large, conic, dark crimson; flesh medium red, firm, mild subacid, very good; runners moderate. Medium late.

Confused with Marguerite. Highly prized for amateur culture and for exhibition; under high culture it produces very large berries of superior quality.

Maximus (S). (*Corsican; Big Berry; Armstrongs Favorite; German Seedling.*) — Said to have originated in Germany. Berry medium to large, irregular round-conic to wedge-shape, light crimson, color very variable; flesh light red, medium firm, mild subacid, good; runners numerous. Midseason. Strongly resembles the New York group of varieties.

Michel (S). (*Michel's Early; Mitchell's Early; Osceola; Ella; Young's Early Sunrise.*) — Originated 1883, by Geo. Michel (pronounced Mike-el), Judsonia, Arkansas, chance seedling, supposed to be of Crescent; introduced 1889. Berry medium to small, round-conic, sometimes slightly necked, dull scarlet; flesh light red, medium firm, acid, fair; runners very numerous. Very early. Has been a prominent shipping variety, especially in the South. Not productive, and very sour. Now being discarded.

Missionary (S). — Originated about 1900, by Nathaniel Gohn, Deep Creek, Norfolk County, Virginia, chance seedling; introduced 1906. Berry medium to large, round-conic, dark crimson; flesh dark red, very firm, acid, fair; runners moderate. Early. Practically identical with Klondike, but earlier. Rapidly supplanting Klondike in many parts of the South.

Nettie (P). — Originated in 1893 by J. H. Black, Son & Co., Hightstown, New Jersey; a Bubach x Yale seedling was crossed with Sharpless and this with Gandy; introduced 1899. Berry large, irregular round-conic to wedge-shape, scarlet; flesh medium red, medium firm, brisk subacid, good; runners moderate. Very late, a little after Gandy. Preferred to Gandy in some sections.

Neunan (S). (*Neunan's Prolific; Charleston Berry; Noonan; Nunan; Newman,* of some.) — Originated by Mr. Neunan, Charleston, South Carolina; introduced about 1870. Berry medium, roundish to round-conic, light crimson; flesh medium red, very firm, acid, fair; runners numerous. Early to midseason. The dominant commercial variety of the South, for shipping north, 1878–1895; now mostly supplanted by Klondike and Missionary.

New York (S). — Originated 1890, by Martha Yates Tanner, Slaterville Springs, New York, seedling of Bubach which was open to pollination by Jessie; introduced 1898. Berry large, irregular wedge-conic, crimson; flesh medium red, medium firm, mild subacid,

good; runners moderate. Midseason. The following varieties, most of which seem to be of authentic independent origin, so closely resemble New York as to be practicably identical: *Hummer, Michigan Pride* (of Kellogg), *Morgan, Oswego, Pocahontas, Roosevelt* (of Cathcoit), *Ryckman.* Also practically identical with Maximus, and its synonyms.

Nich Ohmer (S). (*Nikoma,* erroneously.) — Originated by J. F. Beaver, Dayton, Ohio, seedling of Middlefield; introduced 1898. Berry large, round-conic, dark crimson; flesh medium red, firm, mild subacid, very good; runners few. Midseason. Requires high culture.

Ozark (S). (*Early Ozark.*) — Originated 1902, by Chas. Shull, Sarcoxie, Missouri, Excelsior x Aroma; introduced 1908. Berry medium to large, round-conic, dark crimson; flesh dark red, firm, subacid, very good; runners numerous. Very early. A popular commercial variety; especially valued for canning.

Pan-American (S). — Originated in 1898, by Samuel Cooper, Delevan, New York, thought to be a runner-sport from Bismarck; introduced 1902. Berry medium, round-conic, obtuse, dull scarlet; flesh light red, medium firm, subacid, good; runners practically none. Interesting only as the progenitor of the race of North American everbearing varieties.

Parker Earle (S). — Originated 1886, by James Nimon, Denison, Texas, Crescent x T. V. Munson's No. 3, which was an unnamed seedling of Miner's Prolific; introduced 1889. Berry large, conic, with long neck, dark scarlet; flesh light red, firm, mild subacid, good; runners few. Medium late. Has been a standard variety in the West. Requires rich soil and hill training.

Parson (S). (*Parson's Beauty; Reynolds; Pearson's Beauty.*) — Originated about 1895, by R. G. Parsons, Parsonsburg, Maryland; chance seedling; introduced 1899. Berry medium large, irregular-conic to wedge-conic, bright crimson; flesh medium red, firm, subacid, good; runners numerous. Midseason. Valued in Maryland, Delaware, British Columbia, and several other sections. Pocomoke and Gibson (of Michigan) resemble it.

Progressive (*Never-stop*) (S). — Originated 1908, by Harlow Rockhill, Conrad, Iowa, Pan-American x Dunlap; introduced 1912. Berry medium, wedge-conic to obtuse-conic, dark crimson; flesh dark red, firm, mild subacid, good; runners moderate. Early. An everbearer, and one of the best of its class.

Ridgeway (S). — Originated 1892, by M. H. Ridgeway, Wabash, Indiana, Jersey Queen x Parker Earle; introduced 1897. Berry medium to large, round-conic to oblong-conic, light crimson; flesh medium red, medium firm, mild subacid, good; runners moderate. Midseason to late. Valued in some sections for near market. A good pollinizer for late pistillates.

Royal Sovereign (S). — Originated in England. Berry large, round-conic to wedge-shape, bright crimson; flesh medium red, firm, brisk subacid, good; runners moderate. Very early. A standard sort in England; grown to some extent in Canada, especially on Vancouver Island and the adjacent mainland, and the Kootenay district, British Columbia, and Nova Scotia.

Ruby (of Riehl) (S). (*Riehl.*) — Originated 1890, by E. H. Riehl, N. Alton, Illinois, chance seedling, supposed to be Crescent x Sharpless; introduced 1895. Berry medium to large, round-conic, obtuse, dull dark scarlet; flesh dark red, firm, subacid, good; runners numerous. Medium late. Valued in many sections, especially in Oregon for canning.

Sample (P). — Originated 1894, by J. D. Gowing, N. Reading, Massachusetts, chance seedling in bed of Leader; introduced 1898. Berry large, round-conic, very regular, dark crimson; flesh dark red, firm, subacid, good; runners numerous. Medium late. A standard variety in many places. Commonly pollinated with Aroma, Dunlap and Parson. Snaps off easily in picking.

Seaford (P). (*Lloyd; Lloyd's Favorite.*) — Originated 1892, by Chas. Wright, near Seaford, Delaware, chance seedling; introduced 1897. Berry medium to large, irregular wedge-conic, dark crimson; flesh dark red, firm, acid, good; runners moderate. Midseason. Valued for canning. Hardy.

Superior (S to semi-S). (*Early Superior.*) — Originated in Delaware about 1888; introduced about 1890. Berry medium, irregular wedge-conic, dark crimson; flesh medium red, firm, subacid, good; runners numerous. Medium early. Valued in a few localities, notably at Bridgeville, Delaware.

Thompson (S). (*Lady Thompson.*) — Originated in 1894, by D. A. Thompson, Mt. Olive, North Carolina, chance seedling; introduced 1895. Berry medium, conic, bright scarlet; flesh light medium red, firm, subacid, good; runners moderate. Early. For some years a standard variety in the South for shipping to northern markets;

now largely supplanted by Klondike. A heavy producer on poor soils, but berries soft and of poor color.

Triomphe (S). (*Triomphe de Gand; Triumph,* of some.) — Originated in Belgium, probably by M. de Jonghe, Brussels; introduced here by Ellwanger & Barry, Rochester, New York, about 1855. Berry large, roundish, coxcombed, bright crimson; flesh whitish, firm, mild subacid, very good; runners moderate. Late. This variety and Jucunda are the only foreign sorts that have achieved prominence in North America. Valued under intensive culture on the Pacific coast.

Uncle Jim (S). (*Dornan.*) — Originated 1898, by J. F. Dornan, Glenn, Michigan, chance seedling; introduced 1902. Berry large, irregular round-conic, light crimson; flesh medium red, medium firm, mild subacid, good; runners moderate. Medium late. Very similar to if not identical with New York.

Williams (of Ontario) (S). (*Prince of Orange.*) — Originated by Mr. Williams, Burford, Ontario, Crescent x Sharpless; introduced 1890. Berry large, round-conic to wedge-conic, dark crimson, often with white tip; flesh dark red, firm, subacid, good; runners numerous. Midseason. Has been a popular commercial variety in Canada, especially in southern Ontario.

APPENDIX

STATISTICS ON ACREAGE, PRODUCTION AND VALUE

Statistics of the 12th and 13th census show a decrease of 5.5 per cent in the acreage of strawberries between 1900 and 1910. This decrease, however, is less with strawberries than with most other small-fruits, as is shown in the following table:

Decrease in the Acreage of Small-fruits

	1910	1900	Per Cent Decrease
Strawberries	143,045	151,363	− 5.5
Blackberries and dewberries	49,004	50,221	− 2.4
Raspberries and loganberries	48,668	60,916	− 20.1
Currants	7,862	12,865	− 38.9
Gooseberries	4,765	6,752	− 29.4

This decrease in strawberry planting was most rapid between 1905 and 1910. This contraction followed a number of years of heavy and sometimes injudicious planting, especially in the South and Mississippi Valley. The reaction, however, was not as marked as that which followed the boom years of 1865–70. At present the total acreage apparently is increasing slightly. The value of the 1909 strawberry crop, as compared with other fruit crops of that year, is reported by the census as follows:

VALUE OF DIFFERENT FRUIT CROPS IN 1909

	VALUE	TREES OF BEARING AGE	TREES NOT OF BEARING AGE	PERCENTAGE OF GAIN OR LOSS
Apples . .	$83,231,492	151,322,840	65,791,848	− 16.7
Peaches and nectarines	28,781,078	94,506,657	42,266,243	129.8
Grapes[1] . .	22,027,961	223,701,522	59,928,644	
Strawberries	17,914,000	143,045 acres		− 5.5
Plums and prunes .	10,299,495	23,445,009	6,923,581	76.6
Pears. . .	7,231,160	15,171,524	8,803,733	33.4
Cherries. .	7,231,160	11,822,044	5,621,660	43.6
Apricots .	2,884,119	3,669,714	956,202	57.1
Quinces . .	517,243	1,154,339	509,800	

In 1899 the relative rank was apples, strawberries, grapes and peaches; the respective values, in round numbers, were sixty, fifteen, fourteen and seven millions. The wonderful stride in commercial peach-growing between 1899 and 1909 apparently has removed the strawberry permanently from second place; now it vies with grapes for third place, some years exceeding that fruit in the value of the crop. If the value of the fruit produced in gardens were added to the value of the commercial product, it is probable that the strawberry would rank second to the apple.

The states having the largest acreage in 1910 were:

Maryland	14,292 acres
Tennessee	10,761 acres
Missouri	9,048 acres
New Jersey	8,684 acres
Michigan	8,051 acres
Arkansas	7,361 acres
Delaware	7,194 acres
Virginia	6,606 acres

[1] Does not include wine and raisin grapes.

The counties having the largest acreage in 1910 were:

Sussex, Del.	6,404 acres
Anne Arundel, Md.	3,937 acres
Tangipahoa, La.	3,311 acres
Somerset, Md.	2,859 acres
Norfolk, Va.	2,758 acres
Wicomico, Md.	2,700 acres
Columbus, N.C.	2,548 acres
Rhea, Tenn.	2,399 acres

The Office of Markets and Rural Organization, United States Department of Agriculture, gives the following summary:[1] "The eight most important commercial strawberry districts in 1914 were as follows, ranked according to carload shipments: Central California, 1905 cars; Tennessee, 1571.5 cars; Maryland, 1569.3 cars; Delaware, 1374 cars; southern Louisiana, 1243 cars; North and South Carolina, 967.3 cars; Virginia, 779 cars; Ozark region, 748 cars." The total car-lot movement reported to that office in 1914 was 14,553.2 cars. To this should be added the large quantity that is marketed locally or shipped by express.

While accurate data are not available, it is probable that the 143,045 acres of strawberries grown in the United States in 1910 were considerably more than half of the world total. The nearest competitor is Great Britain. In 1914 John Weathers estimated that the total planting in England was 21,000 acres.

Canada.

The Dominion Census for 1900 did not give the acreage or production of strawberries, but gave the total yield of all small-fruits, in quarts. The Census of 1910 gave the number of "boxes" of strawberries produced that year; also the number of boxes of other small-fruits. About sixty per cent of all the small-fruits produced in 1910 were straw-

[1] Farmers' Bulletin 237 (1915), p. 4.

berries. If we assume that the same ratio held in 1900, for all Provinces alike, and that a box is the equivalent of a quart (it is four-fifths of a quart), the following comparison indicates the relative importance of this industry in the different Provinces:

PRODUCTION OF STRAWBERRIES IN CANADA, 1900 AND 1910

		1900	1910
British Columbia		414,814 qt.	1,662,789 qt.
Manitoba		72,098 qt.	9,941 qt.
New Brunswick		285,030 qt.	779,301 qt.
Nova Scotia		605,672 qt.	633,458 qt.
Ontario		9,739,221 qt.	13,094,462 qt.
Prince Edward Island		90,344 qt.	186,762 qt.
Quebec		1,796,170 qt.	2,304,630 qt.
The Territories	Alberta	12,790 qt.	11,028 qt.
	Assiniboia, East	14,325 qt.	
	Assiniboia, West	2,848 qt.	
	Saskatchewan	1,357 qt.	2,291 qt.

The Dominion Census does not give the strawberry acreage, which is a fairer measure of the importance of the industry than the production of a single year. In 1911, eight per cent of the combined acreage in vegetable and small-fruits was small-fruits, and sixty per cent of the small-fruits was strawberries. If we assume that the ratio was the same in 1891 and 1901, the steady growth of the industry is revealed by the following figures:

ACREAGE OF STRAWBERRIES IN CANADA, 1891, 1901, 1911

YEAR	ACREAGE OF VEGETABLES AND SMALL-FRUITS	ACREAGE OF SMALL-FRUITS	ACREAGE OF STRAWBERRIES
1891	77,140	6,171	3,702
1901	116,517	9,321	5,592
1911	223,506	17,880	10,728

The average yield of strawberries in the United States, according to the Census of 1910, is 1700 quarts an acre. If we apply this ratio to the Dominion statistics for 1911, the area in strawberries then was 10,992 acres, divided approximately as follows:

Alberta	7 acres
British Columbia	978 acres
Manitoba	6 acres
New Brunswick	458 acres
Nova Scotia	372 acres
Ontario	7702 acres
Prince Edward Island	109 acres
Quebec	1355 acres
Saskatchewan	1 acre
	10,992 acres

The total acreage of strawberries in Canada is about equal to that in the state of Tennessee; it is one-fourteenth of the total acreage in the United States. Between 1901 and 1911, however, the Canadian acreage doubled; while in the same period that of the United States decreased 5.5 per cent.

LOCAL CENTERS OF PRODUCTION[1]

Atlantic states.

The large acreage in New England, New York and Pennsylvania is not centralized, as in the South and West. The market-gardens near Boston, mainly in Middlesex County, maintain the standard of intensive culture established there

[1] The acreage figures are quoted mostly from the twelfth and thirteenth census of the United States. The figures of car-lot shipments for 1914 are from Bulletin 237, U.S. Dept. of Agriculture, Office of Markets and Rural Organization. Acreage and production vary greatly from year to year; the figures are not intended to be an exact statement of the comparative importance of the several districts. Many important districts market most of the crop locally; and it cannot be recorded in carloads; hence the census statistics on acreage are the fairest means of comparison.

a century ago. The 6382 acres in New York are scattered over the state. Each of the leading counties — Erie, Ulster and Monroe — has less than 600 acres. Highland and Milton, in Ulster County, and Angola in Erie County, lead in carload shipments. The 4136 acres in Pennsylvania are distributed among many counties.

The largest centers of production in the East are found in the Atlantic coastal plain, from southern New Jersey to Florida. New Jersey has grown strawberries for the New York market since 1830. This state had 8684 acres in 1910. Cumberland, Burlington, Camden and Atlantic counties have the largest acreage. Port Norris, Landesville, Moorestown, Hammondton and Vineland are the most important shipping points. The Delaware-Maryland peninsula is the most highly specialized strawberry district in the world. In 1910 there were 16,250 acres in a territory about ninety miles long and forty miles wide extending from the lower part of Kent County, Delaware, to the upper part of Accomac County, Virginia. In 1914 this district shipped 2599 cars, or nearly one-sixth of all the carload shipments marketed in the United States that year. The industry was established on the peninsula about 1868. Sussex County, Delaware, is the most important shipping county in the country; it had 6404 acres in 1910. In one day, sixty-three cars have been shipped from Bridgeville and forty-four from Selbyville. Maryland is the premier state in strawberry acreage. About one-half of her 14,292 acres are on the eastern shore, or peninsula. On the mainland, Anne Arundel County, which has been growing strawberries for Baltimore and Philadelphia since 1830, maintains leadership, with 3937 acres in 1910.

The Norfolk District, Virginia, has been prominent in strawberry production since 1860. It comprises over 4000 acres, mainly in Norfolk and Princess Anne counties. The 1914 movement was 629 cars. The important district in North Carolina, centering at Mt. Tabor, Mt. Olive and

Chadbourn, did not begin to ship in quantity until 1890. It reached the crest of its development in 1906, when more than 3000 cars were marketed. In 1910 the district included about 5000 acres, of which 2548 and 966 were in Columbia and Duplin counties, respectively. The 1914 movement was 838 cars. Between 1871 and 1890, Charleston, South Carolina, was a prominent shipping point, but it was forced out of the market by the Florida and North Carolina districts. South Carolina has one important district of more recent development, in Horry County, centering at Loris and Conway. This is an extension southward of the North Carolina district. It shipped 128 cars in 1914.

Florida has shipped small quantities of berries since 1878. The acreage in 1910 was 1343, and the 1914 movement was 530 cars. The chief shipping points in northern Florida are Lawtrey and Stark, which marketed 355 cars in 1914. Plant City and Lakeland contributed most of the 152 cars moved from southern Florida in 1914. This district comprises Hillsboro and Polk counties; it has developed since 1896.

Mississippi Valley.

The strawberry industry of Michigan began near Benton Harbor and St. Joseph, Berrien County, in 1861. This county has maintained prominence in this respect; 2041 of the 8051 acres in the state in 1910 were in Berrien County; it shipped 321 cars in 1914. Van Buren, Wayne and Allegan counties each have over 400 acres.

Between 1900 and 1910 the strawberry industry of Ohio declined from 9373 acres to 4706 acres. Ohio now grows strawberries solely for its own markets; only 15 cars were shipped in 1914. Cuyahoga County, with 476 acres, has the largest area. Southern Illinois has been supplying the Chicago market since 1860. The state acreage was reduced from 7113 in 1900 to 5410 in 1910. Pulaski and Union counties lead with 1267 and 573 acres respectively. The movement from Illinois in 1914 was 268 cars. All but four of these

originated in Pulaski and Union counties, mainly at Anna and Villa Ridge.

Tennessee is second to Maryland in total area in strawberries, with 10,761 acres in 1910. The East Tennessee district, comprising Weakley, Gibson, Lauderdale, Crockett and several adjacent counties, began to ship about 1870. In 1910 there were 4546 acres in the district; the 1914 output was 1090 cars. Gibson County leads with 1485 acres. The largest shipping points are Humbolt, Sharon and Dyer. The East Tennessee or Chattanooga district, comprising mainly Hamilton, Rhea and Knox counties, has developed since 1880. In 1910 it had 4338 acres, but the acreage has declined sharply since then; the 1914 output was 481 cars. The only important shipping point in Kentucky is Bowling Green, Warren County, which marketed seventy-five cars in 1914.

The Ozark district, in southwest Missouri and northwest Arkansas, has developed since 1890. In 1910 this district included 9192 acres which were about equally divided between the two states, mainly in Benton, Crawford and Washington counties, Arkansas, and in Newton, Lawrence and Jasper counties, Missouri. The 1914 output was 748 cars. The principal shipping points are Monett, Anderson, Neosho, Sarcoxie, Logan and Pierce City in Missouri, and Johnson, Decatur, Alma, Springdale and Van Buren in Arkansas. The Judsonia district in White County, Arkansas, comprised 1035 acres in 1910; the 1914 output was 471 cars of which 252 originated at Judsonia. Several counties in southwest Arkansas, notably Sevier, recently have begun to ship.

There are few other important shipping points in the upper Missouri Valley. The large area in Jefferson and St. Louis counties, Missouri — 1434 acres in 1910 — is used mostly to supply the near market of St. Louis. Doniphan County, in northeast Kansas, shipped 104 cars in 1914, mainly from Wathena and Troy. A district in southern

Indiana, embracing Clark, Floyd and Washington counties, shipped 101 cars in 1914; New Albany and Borden are the centers of production. Sparta, Monroe County and Bayfield, Bayfield County, Wisconsin, shipped about twenty cars each in 1914. Minnesota has a considerable strawberry industry in Hennepin County, which supplies the St. Paul and Minneapolis markets. Keokuk and Montrose, in Lee County, Iowa, shipped eighteen cars in 1914. With the exception of Colorado, none of the states westward to the Rocky Mountains produces strawberries in quantity. Nevada is least hospitable; her state acreage was reduced from fourteen in 1900 to five in 1910. Colorado's planting totaled 1326 acres in 1910. Steamboat Springs, Fremont County, is the largest shipping point.

The first carload shipment of Alabama strawberries was in 1902, from Castleberry, Conecuh County. This district moved 222 cars in 1914, and the Cullman district, in north Alabama, 100 cars. There has been much new planting in Alabama since 1910, when the acreage was 1167. There are no important districts in Georgia except where the East Tennessee district dips down into Walker County. The chief shipping point in Mississippi is in the Durant district, in the central part of the state, which loaded sixty-six of the 163 cars credited to the state in 1914. Between 1900 and 1910 the state acreage decreased from 1382 to 772.

Independence, Louisiana, began to ship berries to northern markets in 1879. All of the large output from this state — 1243 cars in 1914 — comes from a single parish, or county, Tangipahoa. Independence, Hammond and Ponchatoula are the largest shipping points. In recent years considerable attention has been given to strawberries in Texas, particularly in the Gulf coast region near Galveston, the counties of Smith and Wood in the northeast, and on the lower Rio Grande. In 1910 the state had 2161 acres; 667 were in Smith County, which marketed ninety-nine cars in 1914. Tyler and Winnsboro are the chief shipping points. The

Gulf coast district, including Galveston and Brazoria counties, marketed 115 cars in 1914. Dickinson and Alvin are the most prominent points of production.

Pacific states.

The earliest commercial culture of the strawberry on the Pacific coast was in the vicinity of San Francisco, about 1865. This district, comprising the counties of Santa Clara and Santa Cruz, had 949 acres in 1910 and moved 1532 cars in 1914. Watsonville, Gilroy, Sargent, Vega and Alviso are the largest shipping points. The Florin district, near Sacramento, began to develop about 1885. In 1910 Sacramento County had 450 acres and the adjacent county of Placer 433 acres. The 1914 output was 255 cars. The Los Angeles district began to be prominent about 1885. Between 1900 and 1910 the acreage at this point increased from 363 to 1380.

Hood River, Oregon, was the first point on the Pacific coast to ship in car-lots; the industry began there in 1884. In 1910 the acreage was 512; the 1914 output was 118 cars. Other important shipping points in Oregon are Umatilla County, which loaded sixty-three cars at Freewater and Milton in 1914, and Multnomah County, which had 400 acres in 1910. The strawberry industry of Washington is hardly fifteen years old. The largest acreage is in the Puget Sound district, in the vicinity of Seattle and Tacoma, comprising King and Pierce counties and Vashon Island. Between 1900 and 1910 the acreage in this district increased from 412 to 1297. The movement for 1914 was 182 cars. Other important shipping points in Washington are Kennewick in Benton County, White Salmon in Klickitat County and Spokane.

Canada.

Commercial strawberry-growing in Canada began in Nova Scotia and Ontario about 1865. In 1911, 7702 acres, or two-

thirds of the total strawberry acreage of Canada, was in the province of Ontario, mainly in the southern part. The counties of Halton, Lincoln, Norfolk, Peel and Winthrop have the largest shipping points. There is a considerable acreage in the province of Quebec — about 1355 acres in 1911. It is mainly in the counties of Deux Montagnes, Laval and Terrebonne, near the cities of Quebec and Montreal. British Columbia is the only other province that produces strawberries in quantity; in 1911 there were 978 acres, centering mainly in Nanaimo and New Westminster counties, on Puget Sound. Late berries from Nova Scotia have been an important factor on the Boston market since 1865. The 372 acres in this province are mainly in King's and Yarmouth. The province of New Brunswick has a promising strawberry industry in King's County.

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